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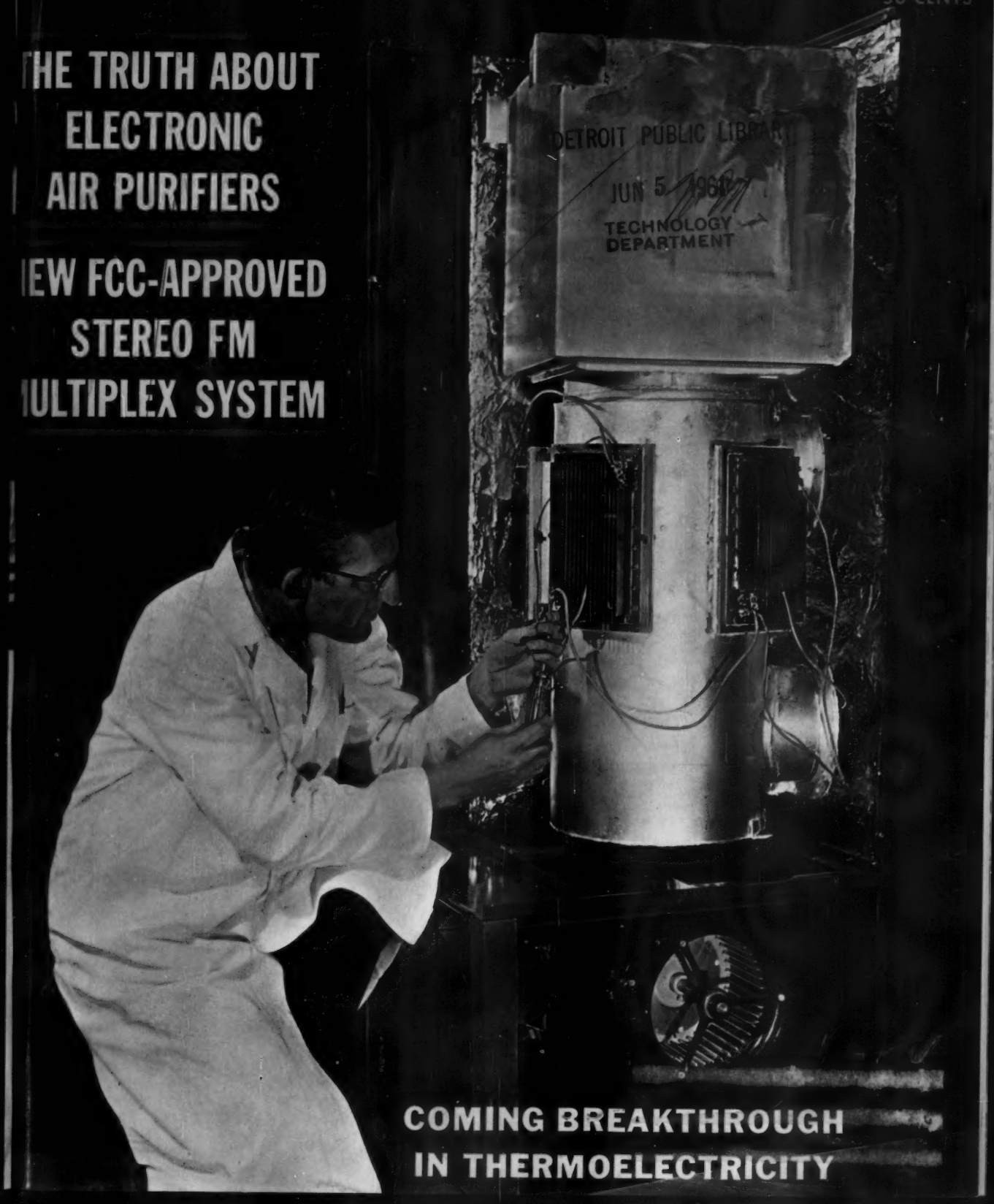

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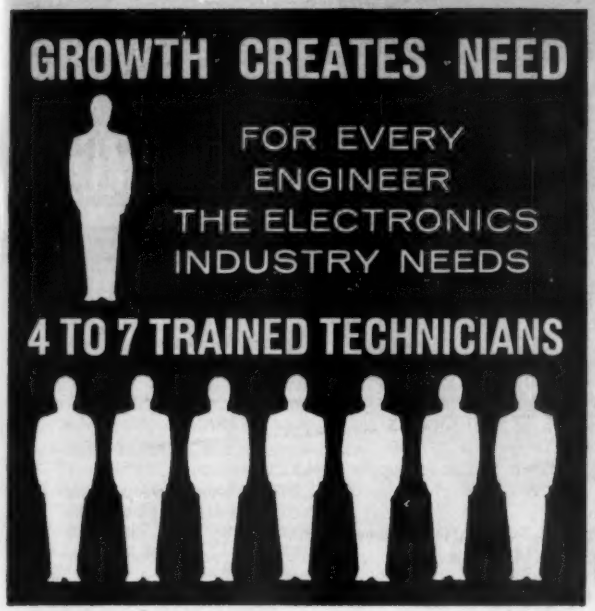

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Editor

FM MULTIPLEXING

WITH the FCC announcement of April 19th approving FM stereo multiplexing, we herald a new dimension in FM broadcasting. This is the beginning of a real FM boom, and its effects will spread —helping all manufacturers of hi-fi component equipment, irrespective of the type of product produced. The word "stereo" will be promoted by FM, AM, and TV stations and will appear in print in many newspapers and magazines as it did when stereo was introduced several years ago. It will, obviously, be a major point of discussion among hi-fi enthusiasts. The result will be that all forms of stereo entertainment, whether on discs, tape, or on the air, will feel the effects.

The FCC approval, which became effective as of June 1st of this year, gave the nod to a system similar to the one recommended by *General Electric* and *Zenith*. It is rather unfortunate that one man, Murray Crosby, who gave much of his time and effort to a multiplex system of his own design, lost out in the end. Much of what has been attained is the result of his continuing efforts over the past few years.

Multiplexing itself is not new to the electronics industry in that we have had multiplexing for background-music (storecast) programs. Now, however, we can have stereophonic records, tapes, and live programs in full stereophonic sound, at home, over a single FM broadcasting channel. The quality will be equal to that of present-day monophonic broadcasts. No longer will it be necessary to use two broadcasting stations, either AM or FM, or any combination of the two, to transmit stereo programs. Now a single transmitter will be able to transmit the two separate signals simultaneously and a single receiver will be able to receive the signals. The new system is compatible in that all present monophonic tuners will function as they have in the past, without any deterioration of program quality. With a proper multiplex FM tuner, or with a suitable multiplex adapter, it will be possible to separate the stereophonic channels which can then be reproduced by a conventional two-channel hi-fi system.

Reports from the industry indicate that almost 50% of FM station owners are interested in stereo broadcasting. It is, at this writing, unreasonable to believe that any large number will be in operation on June 1st. Our guess is that it may take 30 to 60 days beyond the June 1st opening date before any reasonable number of stations will be on the air with multiplexed stereo. The first stations will be those located in areas of high interest in quality programming such as Los Angeles, San Francisco, Chicago, New York, Boston, and Philadelphia.

Tuner manufacturers are in a somewhat better situation. In view of the fact that many of them have been experimenting in their laboratories on possible new designs, one will be able to find some adapters on the market shortly after the June 1st date. As far as new FM sets with integrated multiplex units are concerned, the chances are that none will be available until early Fall.

Interest, at the moment, will certainly center on adapters to convert present FM tuners to stereo operation. These will take two basic forms—one self-powered and the other without a power supply, obtaining "B+" and heater voltages from the tuner itself. There are three or four different designs that could evolve and it will be interesting to see how the various circuits operate. Costs will probably range from $25 to $100. For example, *Sherwood Electronic Laboratories* will have two models available—one at $39.50 that will plug into their Models S3000 and S2200 FM tuners. The other, at $49.50, is self-powered and, according to the company, will operate with any FM tuner. *H. H. Scott, Inc.* has advised us that its self-powered adapter will be available around June 1st at a price just under $100. The adapter will work with any of the company's FM tuners. *Fisher Radio* has also announced a self-powered adapter, at $89.50, which can be used with all the company's tuners and receivers as well as with other wide-band tuners. Little is known about specific circuits but we will keep our readers informed.

One thing we can be certain about is that multiplex adapters cannot be used with just any FM tuner to obtain satisfactory performance. Remember that the requirements for multiplex are much more severe than for ordinary monophonic FM. The multiplex channel which carries the stereophonic information is at a subcarrier frequency of 38 kc. and only quality FM tuners with wide bandwidth and good phase characteristics will provide satisfactory performance.

One word of caution to all manufacturers—let's make sure that all products involved in this new entertainment medium are of the best quality. Public confidence is extremely important and any manufacturer putting out a poor product in a hurry or passing out misinformation will cause further confusion and leave a bad impression on the consumer. Hi-fi component manufacturers, as a group, are quality conscious and this philosophy must be maintained if we want a healthy industry and public acceptance. -30-

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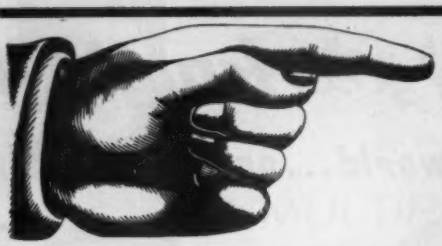

COMING NEXT MONTH

REDUCING CB IGNITION NOISE
You can only use your receiver's full sensitivity if you are not troubled with noise from your car's or boat's ignition system. Here are some simple remedies for this problem.

RELAYS MAKE LOGIC CIRCUITS
With tubes, transistors, assorted diodes, and magnetic devices to choose from, relays still hold their own in the industry. Here's how they work and their application in various circuits.

ELECTRICAL ACTIVITY OF THE HUMAN BODY
Life and electricity are closely related. Here is the nature of some of the signals that are generated within the body along with activity of heart, brain, and muscles.

SERIES "B+" CIRCUITS
The use of "stacked" circuits to obtain different levels of d.c. voltage is becoming increasingly popular, especially in TV sets—and the variety of arrangements is also growing. Variations of this method and troubleshooting techniques are covered here.

3-CHANNEL STEREO CAN BE YOURS
Various methods that may be used to derive a third channel for obtaining a greater stereo listening area by filling the "hole-in-the-middle."

BONDED-SHIELD PICTURE TUBES
Some of the special features of these new CRT types are well known—others are not. Here is the full story—of interest to set owners as well as TV service technicians and set makers.

All these and many more interesting and informative articles will be yours in the August issue of ELECTRONICS WORLD . . . on sale

July 18th

British Electronic Component Output Up in 1960

THE British radio and electronic component industry produced more than seven million parts a day during 1960, according to an estimate in the 28th Annual Report of the Radio and Electronic Component Manufacturers' Federation. The year's total of 2650-million components was valued at £130 million ($364,000,000). This figure does not include tubes, transistors, and cathode-ray tubes.

This output—an all-time record—represents an increase of more than 10 per-cent over the previous year despite setbacks in domestic television.

Exports of components increased by 36 per-cent compared with 1959, Europe for the first time displacing the Commonwealth as the principal consumer. The USA again headed the list of buyer-countries with purchases valued at £4.8 million ($13,440,000).

The next in importance were Australia with £2.1 million ($5,880,000); Canada with £1.8 million ($5,040,000); India with £1.2 million ($3,360,000); Sweden with £1.1 million ($3,080,000); Norway with £1.06 million ($2,968,000); and Eire with £1.5 million ($2,940,000). Major gains were recorded in Australia, Sweden, and Norway.

Sales to Sweden and Norway were more than double the 1959 figures—a position which is being followed up by holding an exhibition of British radio and electronic components in Stockholm during October.

China was the leading buyer of British test equipment in 1960, taking a total worth £186,000 ($520,800).

The Federation estimates that the output of the whole radio and electronic industry, including receivers, tubes, components, and capital goods for communications, broadcasting, navigational aids, and industrial applications, is approximately £400 million ($1,120,000,000), not including certain applications for which there are no figures available to the public.

Exports for the whole industry are estimated at £59 million ($165,000,000), the latter representing an increase of 6.5 per-cent over 1959.

Figures on exports of all electrical products show that the radio and electronic group is the biggest exporter and the only major export section of the industry to show a substantial increase in exports for the year.

The Federation has 218 members, comprising 161 ordinary members and 57 associates, compared with 214 last year. In addition to the technical committee and its sub-committees, there are 24 technical panels dealing with the principal components and materials produced by member-firms. Membership of the panels is not restricted to members of the Federation, but is open to all bona-fide British manufacturers of components, accessories, and materials concerned.

—30—

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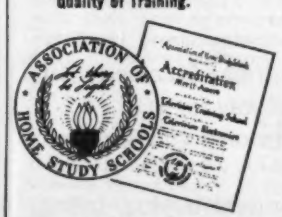

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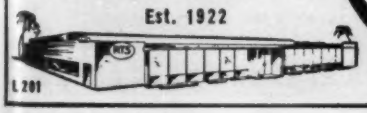

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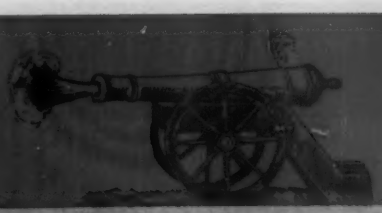

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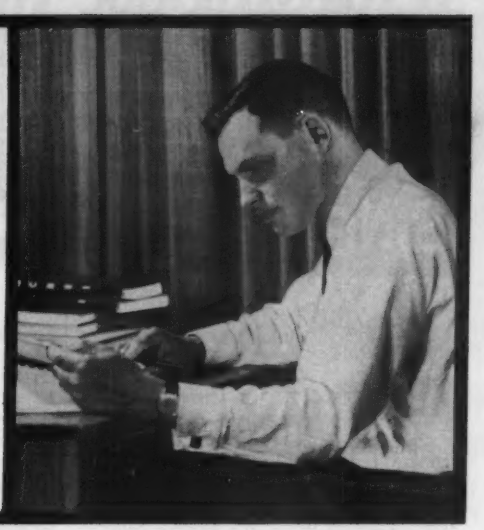

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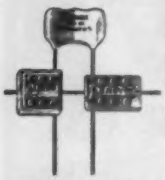

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LETTERS FROM OUR READERS

DIODES ARE DIFFERENT

To the Editors:

I found the article "Diodes Are Different" by Mr. Hazlehurst in April 1961 ELECTRONICS WORLD to be interesting. However, I doubt that the fuse in the center-tap of the transformer in Fig. 3 will give him the protection he is after. Presumably this fuse is intended to blow if the diodes on one side fail. If this should happen and the fuse blows, the diodes remaining on the other side would now have the full secondary voltage applied to them without any limiting resistance except for the surge resistor and the source impedance of the transformer so that they would quickly fail.

GRADY B. FOX, JR.
Rochester, New York

Reader Fox makes a good point. Here is a portion of the author's reply that covers circuit fusing.—Editors.

Dear Mr. Fox:

Your observation is, of course, quite correct and makes an interesting point. The center-tap fuse will not protect the string of diodes and was not meant for that purpose. This fuse is to protect other circuit components.

Actually, the problem you have raised is that of determining the best way to protect what you want protected. A fuse in the transformer primary would save the transformer, and might possibly save one diode leg. However, a primary fuse heavy enough to carry the entire electrical load may not afford sufficient protection to some elements in the high-voltage circuit. On the other hand, a center-tap fuse, in this particular case, would not protect the diodes nor would it protect the transformer unless a diode junction opened up. You have to pay your money and take your choice.

J. H. HAZLEHURST
Kenilworth, Ill.

* * *

TV COMMERCIAL KILLER

To the Editors:

We noted the article "TV Commercial Silencer" by Robert Mack in your April issue.

It is no longer necessary to suffer through television commercials. An inexpensive electronic device can silence the sound portion of the commercial and then restore the sound when the user so wishes. This amazing device is composed of a 10-20 ohm resistor and a s.p.d.t. switch. Look, ma, no thermal relays!

Seriously, though, I fail to see the purpose of the relatively complicated device suggested in Mr. Mack's article. I feel that it is more convenient for the user to be able to switch the sound off and on when he wishes, instead of relying on the arbitrary one-minute time constant of a thermal relay.

DAVE WINEGAR
San Francisco, Calif.

We know there are simpler ways of killing commercials. As a matter of fact, we have run such circuits ourselves in the past using a load resistor and a switch. The article in April was an attempt to add a degree of automaticity that the simple switch does not have.

Also, some of our readers have taken us to task for showing a blank TV screen. Actually, our commercial killer silences only the TV sound as we pointed out in the subhead directly under the photo. There is still a picture on the screen but because of the lack of focus in our photo, it cannot be seen.—Editors.

* * *

ARTICLES FOR THE BLIND

To the Editors:

Enclosed is a listing of the articles from your magazine which have been recorded on tape by the Southeast Amateur Radio Club's Library for the Blind (SRLB), for monthly circulation to its scores of members. We thank you for your permission to tape these articles and we assure you of the appreciation of the entire membership.

WARREN SLADKY, W8CTZ
Cleveland, Ohio

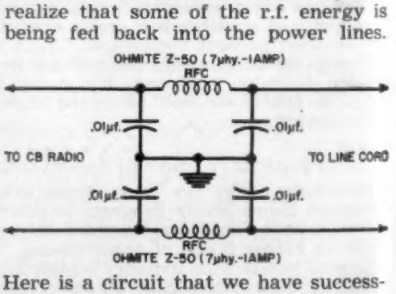
Almost 30 of our articles have been taped for this worthwhile cause and we are happy to cooperate with it.—Editors.

* * *

CB INTERFERENCE

To the Editors:

Those who are experiencing TV interference from their CB sets may not realize that some of the r.f. energy is being fed back into the power lines.



Here is a circuit that we have successfully used to eliminate this interference.

RICHARD MOLLENTINE
Olathe, Kansas

Thanks to Reader Mollentine for his suggestion. The circuit should be installed as close to the CB transceiver as

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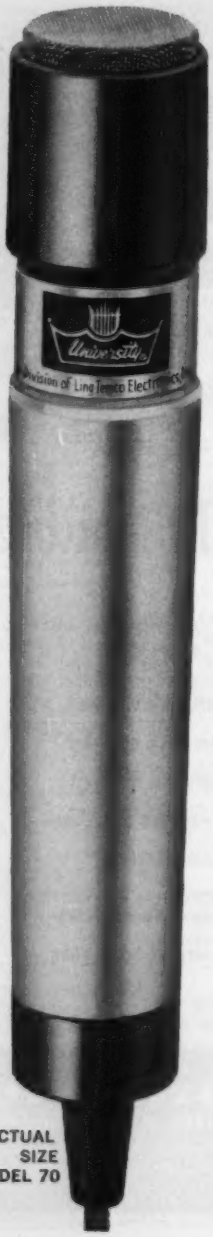


ACTUAL SIZE MODEL 70

possible with a short ground connection run to the chassis of the transceiver itself.—Editors.

* * *

HIGH-QUALITY T.R.F. AM TUNER

To the Editors:

After building the T.R.F. tuner described in your April issue, I have been unable to get it to work properly. I seem to be losing the signal at the plate of V_2 with motorboating and howling at the output.

ARTHUR SCHWARTZ
Dayton, Ohio

There has been quite a bit of interest in the tuner mentioned above. Some of our readers have had the same problem as Reader Schwartz. The following comments from the author should clear up the difficulty.—Editors.

Dear Mr. Schwartz:

I have built up several of these tuners since submitting the manuscript and have had good results with all of them. The circuit is straightforward, with no gimmicks, and should be easily duplicated.

Your trouble may be r.f. feedback due to improper lead dress in the r.f. sections of the tuner. To check, connect a v.t.v.m. across R_8 and measure the a.g.c. voltage developed. This should be less than several tenths of a volt without signal, and several volts with a station tuned in.

If your tuner is oscillating, re-arrange the grid and plate leads of V_1 and V_2 to make these as short as possible. Also try shielding these leads. All a.g.c. bypass capacitors, as well as screen and cathode bypasses, should always be checked.

If all the above attempts fail, increase R_3 and R_4 upward to a maximum of 220 ohms. This will decrease the gain of V_1 and V_2 often enough to eliminate the feedback condition.

JOHN POTTER SHIELDS
Mansfield, Ohio.

* * *

FOUR-CHANNEL STEREO

To the Editors:

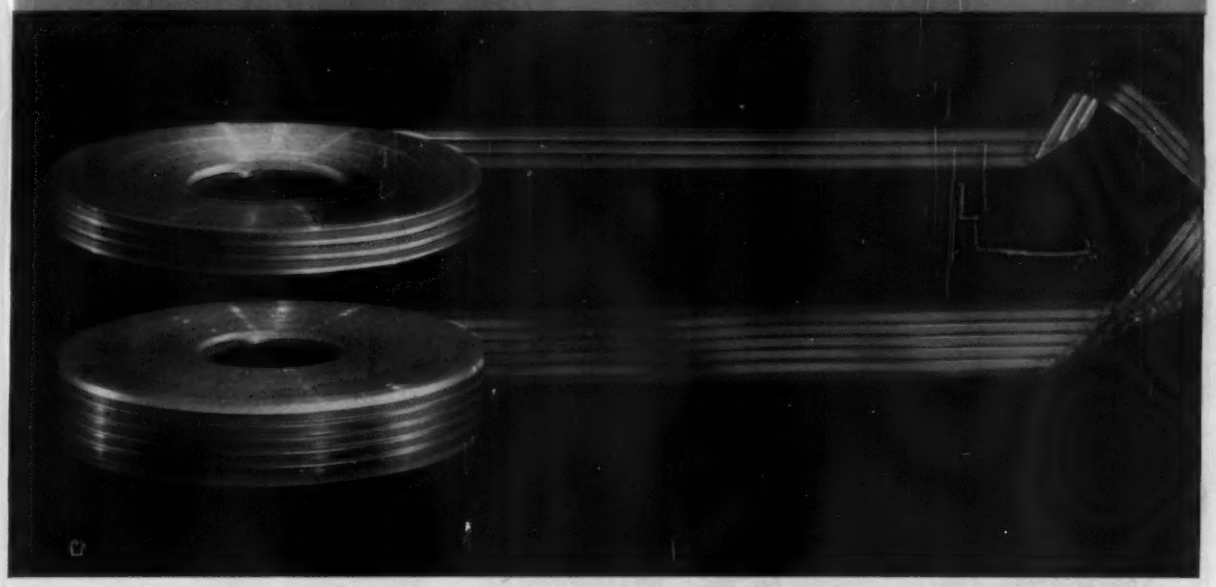
A significant service has been performed by your publication in bringing to your readers' attention the four-channel stereo system in your May issue.

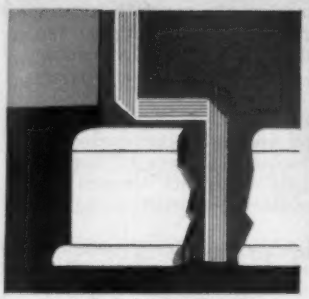
However, we have some doubts about the concept of using staggered heads to achieve the desired result. It would appear that if the four-track idea becomes commercially popular, the staggered head arrangement would become outdated even more rapidly than did staggered heads for two-channel tape.

KARL C. THOMAS
Fairborn, Ohio

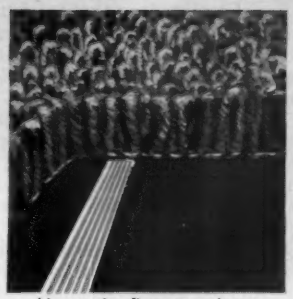
The article in question describes an experimental system which used two presently available two-track heads. It would be possible to combine all these heads in one housing, although crosstalk might be a problem. As a matter of fact, there are some tape heads used in computers that have as many as a dozen separate heads within a single housing. —Editors. —30—

In ELECTRONIC COMPONENTS if it's news, expect it first from IRC

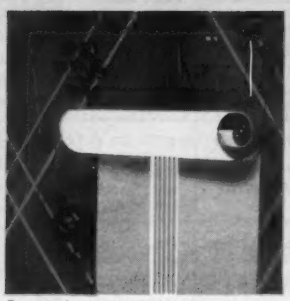




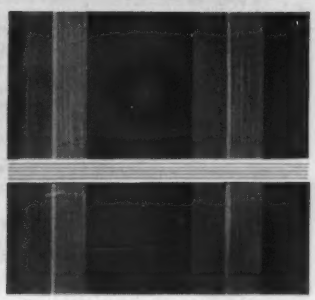
Installs behind surbases



Lies under floor coverings



Conceals easily behind wallpaper



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	Course	Qualifications	Length of Course
A	Advanced Electronic Technology (T-3)	High School grad, with Algebra, Physics or Science	Day 2¼ yrs. Eve. 6¾ yrs. (N.Y.) 4½ yrs. (L.A.)
B	Television and General Electronics (V-7)	2 yrs. High School, with Algebra, Physics or Science	Day 1½ yrs. Eve. 4½ yrs. (N.Y.) 3 yrs. (L.A.)
C	Radio and Television Servicing (V-3)	2 yrs. High School, with Algebra, Physics or Science	Day 9 mos. Eve. 2¼ yrs. (N.Y.) 1½ yrs. (L.A.)
D	Transistors	Radio background	Eve. 3 mos.
E	Electronic Drafting (V-11 V-12)	2 yrs. High School, with Algebra, Physics or Science	Eve. Basic: 1 yr. Advanced: 2 yrs.
F	Color Television	Television background	Eve. 3 mos.
G	Audio-Hi Fidelity	Radio background	Eve. 3 mos.
H	Computer Programming (C-1)	College Graduate or industry sponsored.	Eve. 24 weeks
I	Technical Writing (V-10)	High School Graduate	Eve. 2¼ yrs. (N.Y.) 1½ yrs. (L.A.)
J	TV Studio Production (S-1)	High School Graduate	Day 15 weeks Eve. 45 weeks
K	Digital Computers	Electronics background	Eve. 3 mos. (L.A.)
L	Preparatory Math & Physics (P-O)	1 yr. High School	Day 3 mos.
M	Preparatory Mathematics (P-OA)	1 yr. High School	Eve. 3 mos.
N	Home Study Courses	Choose from: Radio and Electronic Fundamentals, TV Servicing, Color TV, Transistors, and Automation Courses. Catalog free on request.	

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Please send me your FREE catalog. I am interested in the courses circled below.

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For Home Study Courses See Ad On Opposite Page

Demand for Electronics Manpower to Exceed Supply in N.Y.C. Area

Greatest demand expected for electronics technicians, engineers, and draftsmen.

DEMAND by 1964 for technical and skilled manpower for the metropolitan area's fast-growing electronics manufacturing industries will outstrip supply from present training sources by close to 1000, the N.Y. State Labor Department's Division of Employment reported recently. This forecast is made in "Manpower Requirements in Electronics Manufacturing—Outlook to 1964 in the New York Metropolitan Area," a 154-page report of a 1959 survey conducted by the Division. Aim of the survey was "to give educators and the industry itself guide-lines for planning needed occupational training."

Need for 9500 more employees—7200 for growth and 2300 for replacement—in 41 key occupations between 1959 and 1964 was predicted by the industry, the report shows. This represents a 36 per-cent net rise in these occupations—singled out for close examination because they require long training or education, are important to defense production, or employ relatively large numbers. In 1959 they made up nearly half of the industry's 40,000 employment total in the metropolitan area. The total has since grown to more than 44,000.

For the guidance of school counselors and youth the report provides detailed job guides for 36 of 41 occupations: the nature of each job, the required aptitudes, abilities, education and experience, the lines of promotion, expected opportunities, and 1959 wage ranges.

Prospects for attracting some 1300 needed professional employees—electrical, mechanical and industrial engineers, physicists, mathematicians, and technical writers will depend on the industry's ability to compete with other demand in a nation-wide labor market and cannot be predicted, the report concludes.

Shortages are expected in skilled occupations common to all metal-working industries and already in short supply—tool and die maker, machinist and skilled machine tool operator; and in occupations unique to the electronics industry which require training beyond the high-school level.

The report makes a "very tentative" estimate that the supply of workers with post-high-school training in electronics will be about 500 short of the 1600 the industry expects to need.

The survey showed community colleges and technical institutes in the area expected to graduate about 8500 students between 1959 and 1964, instead of the 6100 that continuation of the 1959 enrollment rate would have yielded, "but many other industries will be competing for this trained manpower."

Most of the new jobs—4700 out of 7200—are expected in New York City, according to the report. Firms in Nassau-Suffolk will add 1500, and in Westchester-Rockland, 1000. Most of the needed replacements will be unskilled and semi-skilled women. Because the industry is young, there will be few retirements and deaths.

The five occupations expected to show the largest percentage increases are mathematician, physicist, technical writer, electronics technician and first-class mechanical assembler. The skilled jobs of mechanical inspector, machine tool operator, and electronics inspector will increase by about 50 per-cent.

Numerically, the greatest demand in the professional-technical field will be for electrical engineers, electronics technicians, draftsmen, and mechanical engineers: in the skilled fields—the first class mechanical assemblers, machinists, and first-class wirers.

The report includes detailed tables, by occupation and locality, on employment and expected requirements by 1964 in the three branches of the industry: communications equipment manufacture, electronic components manufacture, and radio-TV-phonograph manufacture. —30—

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can be the smartest investment you'll make in your *entire lifetime!*

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2. You get comprehensive training in your choice of many complete up-to-date Courses . . . including Radio and Electronic Fundamentals, TV Servicing, Color TV, Transistors, Automation.

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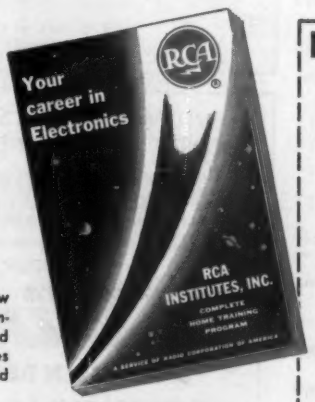
6. You get top recognition — Graduates of RCA Institutes now work for leaders in the electronics field; many have their own businesses. This record is true tribute to the high quality of RCA Institutes training.

Send for this 64-page Home Study Catalog FREE!



RESIDENT SCHOOL Courses in New York City and Los Angeles offer comprehensive training in Television and Electronics. Day and Evening classes start four times each year. Detailed information on request.

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For Resident School Courses See Ad on Opposite Page

NEW...Home TV Signal Amplifier

TRANSISTORIZED WINEGARD "BOOSTER-PACK"

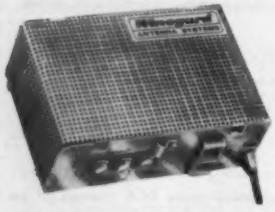
Clears up snow, improves contrast, adds miles to reception distance!

Here's the most unusual (and most useful) home TV-FM signal amplifier you've ever seen! Winegard "Booster-Pack" utilizes new low noise, high gain transistor* to give you a flat gain of 16 db on the low band and FM . . . a flat gain of 14 db on the high band.

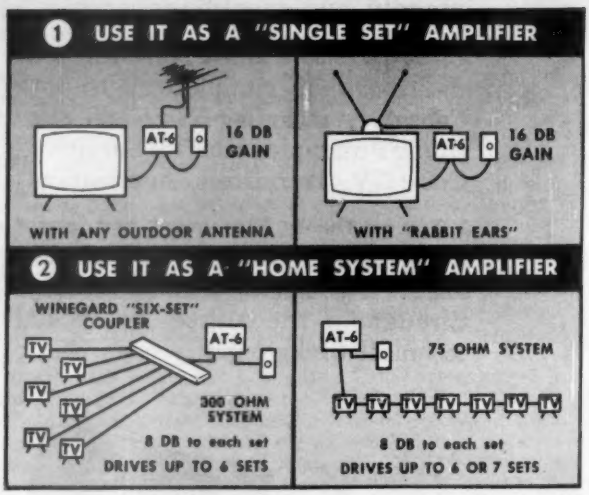
Shock-proof . . . full AC chassis with AC isolation transformer (not AC-DC). Draws only 1.2 watts . . . cost only 27c per year to operate if left on continuously. No heat radiation. Can be mounted on back of TV set, on baseboard, in basement, attic, etc. Use "Booster-Pack" as a single set booster or as a home system amplifier for up to 6 or 7 sets. (See right)

*Special transistor so new that this amplifier could not have been produced until now.

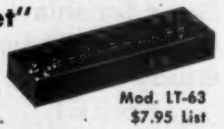
No other amplifier under $80.00 has all these features!



- Drives from 1 to 7 TV/FM sets
- Ideal for color
- Power Consumption: 1.2 watts
- Gain: Low and FM: 16 db
  High: 14 db
- Input: 300 ohm
- Output: 300 ohm and 75 ohm
- Transistor*: Low noise, high gain type
- Power Transformer: AC isolation type
- Gain Control: 3-position switch
- AC Outlet: To receive TV set power plug
- Precision Wiring . . . finest quality throughout



New! Winegard "Six-Set" SIX SET TV COUPLER



For connecting up to 6 TV sets to "Booster-Pack" or to Winegard Powertron antenna. 300 ohm input and outputs. Low insertion loss, positive isolation between sets.

Mod. LT-63
$7.95 List

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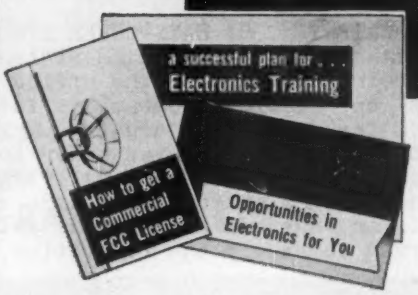

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- ☐ Manufacturing
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- ☐ Broadcasting
- ☐ Home Experimenting
- ☐ Telephone Company
- ☐ Other _____

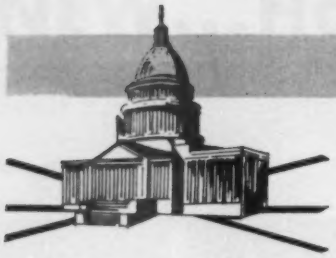
In what branch of Electronics are you interested? _____

Name _____ Age _____

Address _____

City _____ Zone ____ State _____

RN55



Latest Information on the Electronic Industry

Spot News

By ELECTRONICS WORLD'S WASHINGTON CORRESPONDENT

ELABORATE COMMUNICATIONS SYSTEM USED IN "FREEDOM 7" SPACE FLIGHT—An assortment of well-integrated communications equipment enabled Astronaut Cmdr. Alan B. Shepard, Jr. to maintain perfect contact with ground stations during his remarkable flight. His cockpit was equipped with ultra-high and high-frequency radios, radar-recovery beacons, a command receiver, and telegraph code key. Three 3000-watt-hour batteries and a 1500-watt-hour battery, connected in parallel, provided power. The u.h.f. link (voice) was the primary contact source. In addition, a telemetry system beamed to flight surgeons on land kept track of the pilot's respiration rate and depth, electrocardiograms, and body temperature.

RADAR-SONAR SIGNALS SENT BY BATS UNDER STUDY BY NAVY—A natural radar-sonar system, which it is believed tropical bats use to locate fish under water, is now being surveyed by the Office of Naval Research. The project, part of a biological orientation program, is intended to help scientists establish improved concepts for developing advanced navigation, communication, and detection techniques. The particular species under investigation, known as Noctilio leporinus, apparently locate fish targets while flying over water and sending out ultrasonic pulse emissions. During observations made recently in Panama and Trinidad by Prof. D.R. Griffin, Harvard University, an ultrasonic detector and a small tape instrument served to record the repetition rate of the bat's emissions.

LONG-RANGE SATELLITE RADAR TO BE BUILT FOR AIR FORCE—A $3,800,000 radio research facility, employing a 120-foot wide saucer-shaped antenna with a surface contour of unprecedented accuracy, is being built for the U.S. Air Force at Tyngsboro, Mass. for global communications and space studies. The research tool, located on Haystack Hill, a short distance from Lincoln Laboratory's famed Millstone Hill radar, will be used to probe the troposphere and ionosphere; also to study the atmospheric irregularities that may limit radio antenna performance—how narrow a beam can actually be produced and how accurately it can be aimed—similar in principle to the limits the atmosphere imposes on astronomical observations with large optical telescopes.

ENERGY OF VENUS MEASURED AT SHORT WAVELENGTHS—Scientists of the Naval Research Laboratory in Washington have been able to measure energy from Venus at the very short wavelength of 4.3 millimeters. Believed to be the first time such measurements have been made, the results are expected to resolve the question of the surface temperature of the planet and might influence plans for future space probes to Venus. Previous radio telescope measurements at wavelengths of about 10 and 3 centimeters placed Venus' temperature at 600 degrees F, hot enough to melt lead. Later a temperature of 280 degrees was recorded using radio waves 8.6 mm. long. Analysis of the new measurements may settle the question. In these tests, the temperature of the radiation-emitting source is inferred from the power of the noise received at any given wavelength.

IMPROVED RADAR BEACON TO EXPAND AIR TRAFFIC CONTROL CAPACITY—An air traffic control radar beacon system employing side-lobe suppression, an electronic means of detecting and identifying aircraft within a range of 200 nautical miles, has been adapted as a national standard. The new beacon will provide improvement in present systems, expanding capacity to handle the future volume of air traffic. Currently, beacon systems use a rotating beam which transmits energy in other directions causing aircraft to reply too often. The new feature corrects this deficiency by preventing all aircraft, other than those within the main rotating beam, from replying.

ARMY TESTING ELECTRONIC TECHNIQUES TO CHECK AIRCRAFT SAFETY—Electronic checkout techniques, similar to those used in missile launchings, are now being tested on Army aircraft to determine if the planes are safe for flight. Known as project Alarm (Automatic Light Aircraft Readiness Monitor), the concept envisions the use of strategically placed sensors to forecast, electronically, the condition of various critical mechanical and structural components. -30-

SPECIAL INTRODUCTORY OFFER FROM GENERAL ELECTRIC

NEW G-E STOCK SAVER KIT CONTAINS 14 CAPACITOR TYPES THAT MEET 90% OF YOUR TUBULAR REPLACEMENT NEEDS

The capacitors with this handy kit are part of General Electric's new line of "Service-Designed" capacitors—each engineered and clearly marked for range of capacitance and voltage requirements. No more guessing or substituting for exact replacements. Save time and cost of single-unit ordering and pickup. With your Stock Saver Kit you can carry a minimum inventory and turn it into profits faster.

The complete "Service-Designed" line—especially designed for replacement sales—contains tubulars, twist-prong and miniature electrolytic and paper Mylar* types. Reduce from 1,200 to 295 the types needed to make all aluminum electrolytic capacitor replacements.

Get your G-E Stock Saver Kit, plus the most complete catalog and replacement guide ever published, from your G-E capacitor distributor. General Electric Company, Electronic Components Division, Room 7149D, Owensboro, Kentucky.

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LOADING FOR EFFICIENCY in

Mobile Citizens Band

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4 NEW TOP LOADED WHIPS

STAINLESS STEEL
Model No. TLW-M

Important new advancement in automotive whip design utilizes top loading to raise radiating portion of antenna to highest possible point. Top loaded design also raises radiation resistance to 52 ohms for perfect match to coax cable. Improved matching, increased effective height of radiating portion, combined with the higher mounting position on vehicle (made possible by reduced size of whip) add up to brilliantly superior performance. All these improved features are for the first time available in a stainless steel whip less than half size (only 50" overall). Top loading polyethylene-coated coil capsule is approx. same diameter and permanently fused to stainless steel section. Impervious to any climate; extremely rugged. Complete with chrome plated, single hole mounting, top-loaded body mount and coaxial receptacle.

$7.17 net

Model TLW

Identical to above Model TLW-M except complete with standard ⅜" by 24 threaded base stud, fitting most automotive mounts, with or without spring.

$5.37 net

TELESCOPING
Model No. TLWT-M

Identical to Model TLW-M except with telescoping stainless steel and chrome plated brass whip sections. Telescopes from 50" to 28" for easy garaging. Similar in appearance to standard AM auto broadcast whip, the Model TLW-M may be used with Model CPR Coupler unit as an high efficiency antenna for both Citizens Band and AM Radio.

$7.17 net

Model TLWT

Identical to above Model TLWT-M, except furnished with standard ⅜" by 24 threaded stud, fitting most automotive mounts, with or without spring.

$5.97 net

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Within the Industry

FREDERICK R. LACK has been named to the newly created post of senior vice-president in charge of research of the *Sprague Electric Company.*

He joined the firm in 1959 soon after his retirement as vice-president and director of the *Western Electric Co.* He had been associated with the *Bell System* since 1911.

Mr. Lack received the 1959 EIA "Medal of Honor" for his many contributions to progress in the electronics industry. He has also served as president of the American Standards Association and was director of the Army-Navy Electronics Production Agency for a period during World War II.

He is a Fellow of the IRE, a member of AIEE, the American Association for the Advancement of Science, the American Physical Society, and the Harvard Engineering Society.

* * *

DELCO RADIO DIVISION has announced production of its 30 millionth radio, manufactured just two weeks short of the 25th anniversary of the Division.

Established May 1, 1936, the Division began operations in Kokomo, Indiana with some 400 employees. Average employment is now in excess of 4000. The Division produced more than two million car radios during 1960.

The 30 millionth radio will be displayed in the lobby of the Division's new 125,000-square-foot research and development building.

* * *

GENE K. BEARE has been named president of *Sylvania Electric Products Inc.*, succeeding **ROBERT E. LEWIS** who resigned to become president of *Perkin-Elmer Corporation . . . Cornell-Dubilier Electronics* has established a market research and product planning department under the direction of **GLENN A. DUSCH . . . MARCEL G. DEKERS** has joined the field sales promotion staff of *Sprague Products Company* where he will assist distributors with their marketing problems . . . **JOHN T. HARTLEY** has been named vice-president, corporate marketing for *Radiation Incorporated . . .* **EARL TEMPLETON,** distribution sales manager of *P. R. Mallory & Co., Inc.*, has been elected one of two representatives of the EIA on the board of directors of the Electronics Industry Show Corp. **HAROLD BERSCHE,** distribution sales manager for *RCA,* is the hold-over appointee . . . **HAROLD T. NEAL** has been appointed plant manager for the electronics division of *ACF Industries, Inc.* He was formerly associated with *Cook Electric Company* and *Stromberg-Carlson . . .* **J. PENN RUTHERFOORD** has joined *International Resistance Co.* as executive vice-president. He was general manager of *Raytheon Co.'s* commercial apparatus and systems division . . . **JAMES L. BERNARD, JR.,** president and founder of *Communication Products Company, Inc.* died recently. His son, **ROBERT W. BERNARD,** has assumed control of the firm.

* * *

ELECTRONIC INDUSTRIES ASSOCIATION has announced that while production of picture tubes, radios, and TV sets increased in February after the January slump, factory production and retail sales of phonographs continued their downward trend. Both mono and stereo units were involved in the decline.

* * *

HARTLEY BOND has been appointed marketing manager for the New Bedford plant of *Cornell-Dubilier Electronics Division.*

In his new post, Mr. Bond will be responsible for the marketing of ceramic capacitors, oil-paper or film capacitors, pulse networks, delay lines, and filters.

He joined the firm in March of last year after having served *General Electric's* semiconductor and capacitor departments in various sales and marketing capacities.

* * *

SPRAGUE ELECTRIC COMPANY has set up a Resistor Division in which all resistor manufacturing, engineering, and marketing activities will be consolidated at the firm's Nashua, N.H. plant under the direction of Richard K. Morse. . . . **ALL-STATE ELECTRONICS, INC.** and **CENTRAL ELECTRONICS,** Dallas-based electronic parts distributors, have merged. Both firms specialize in industrial and service accounts. . . . **FIDELITONE, INC.** of Chicago has acquired **JVM MICROWAVE COMPANY** of Brookfield, Ill. . . . **SYSTEMS ENGINEERING LABORATORIES INC.** has been established in Fort Lauderdale to produce data systems for defense, space exploration, and industrial uses. . . . The formation of **AEROSPACE CONTROLS CO.** has been announced. Specializing in the development and manufacturing of special instruments and controls for space travel and related application, the new firm has established headquarters at 602 Colorado Ave., Santa Monica, Calif. . . . **METHODE MANUFACTURING CORP.** of Chicago has announced its acquisition of **THERMO-CERAM,** Addison, Ill. manufacturer of hermetic seals and standard

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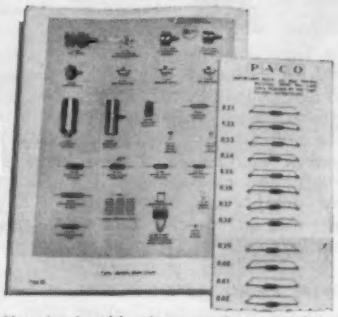
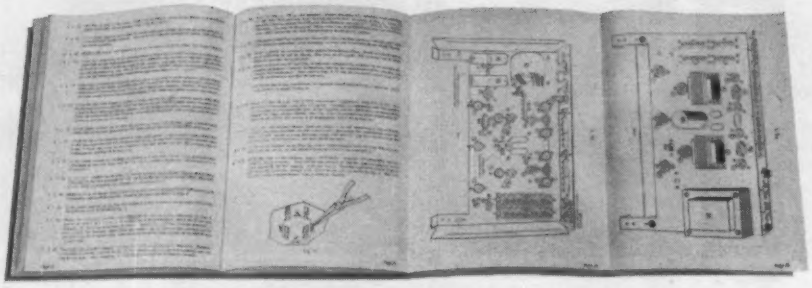
THE KIT YOU BUILD IS A PACO

COMPARE THESE PACO FEATURES:



No mistaken identity or endless searching. Parts are clearly pictured and labeled; resistors are neatly mounted and identified!



Step-by-step instruction book makes assembling a Paco Kit foolproof! Paco gives you giant, fold-out diagrams on corresponding instruction pages so you can see both at the same time.

PACO Model C-25
IN-CIRCUIT CAPACITOR TESTER KIT

Reveals dried out, shorted, or open electrolytics—in the circuit—with Paco's exclusive Capacity Dial. Instantly finds open or direct shorted capacitors without removing from circuit. Great time saver!

Specifications:

SIMPLE SEQUENTIAL TEST: reveals open or shorted capacitors, including electrolytic types.

ELECTROLYTIC DIAL: indicates actual electrolytic values while capacitor is in-circuit; any electrolytic which yields a capacity reading on Electrolytic Dial is automatically revealed as not open or shorted.

ELECTROLYTIC TEST: indicates in-circuit electrolytic capacity from 2 mfd to 400 mfd in two ranges; condenser is automatically proved non-shorted and not open if Capacity Reading can be obtained.

Model C-25: Kit, complete with PACO-detailed assembly-operating manual. **Kit Net Price: $19.95**

Model C-25W: Factory-wired, ready to operate. **Net Price: 29.95**

PACO Model DF-90
TRANSISTORIZED DEPTH FINDER KIT

Protect your boat against shoals and underwater hazards with this compact, easy-to-read depth finder. Transistors prolong battery life, provide utmost accuracy and portability. A boon to fishermen—locates hard-to-find schools of fish. A low cost safety device for every boat owner.

Specifications:

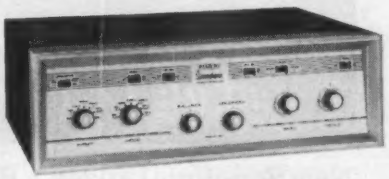
FULLY TRANSISTORIZED: 5 transistors, with a low battery drain for extremely long battery life.

HIGH INTENSITY INDICATOR: for sensitive, accurate response under all conditions.

FAST, EASY READINGS: made possible by means of over-sized scale calibrated at one-foot intervals from 0 to 120 feet.

Model DF-90: Kit, complete with PACO-detailed assembly-operating manual. **Kit Net Price: $84.50**

Model DF-90W: Factory-wired, ready to operate. **Net Price: $135.50**



PACO Model SA-40
STEREO PREAMP-AMPLIFIER KIT

Assemble a superb home music system with this true 40 watt stereo preamp-amplifier. Unmatched flexibility, less than 0.5% distortion, and handsome design make this the ideal component for music lover and audiophile alike!

Specifications:

MUSIC WAVEFORM POWER OUTPUT: 25 watts per channel (50 watts total).

RESPONSE: 30 cps to 90Kc, ± 1.0% db

HARMONIC DISTORTION: less than 0.5% at 20 watts per channel output.

Model SA-40: Kit, complete with black and gold case and PACO-detailed assembly-operating manual.....**Kit Net Price: $79.95**

Model SA-40W: Factory-wired, with black and gold case, ready to operate. **Net Price: $129.95**

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Mail this coupon for the complete Paco catalog of electronic equipment kits, including test instruments, measuring instruments, and high fidelity components.

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City..... Zone..... State.....

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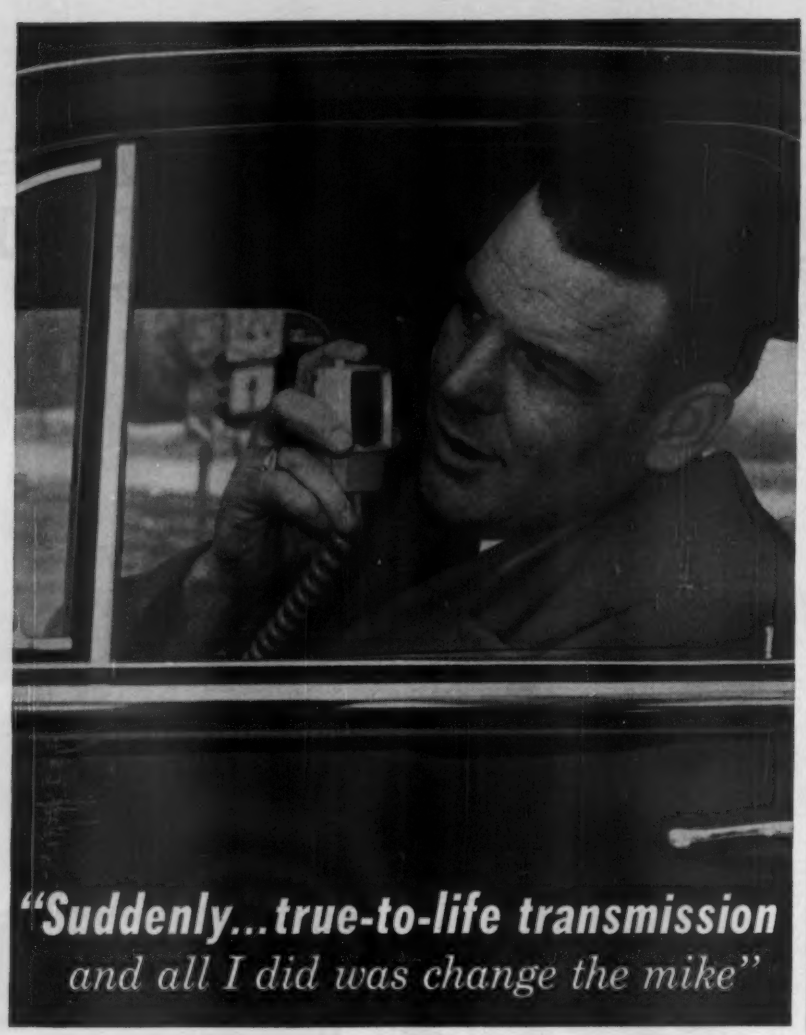

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and special glass-to-metal header assemblies . . . **HOFFMAN ELECTRONICS CORPORATION** has withdrawn from the TV and stereo field to concentrate on military, semiconductor, and industrial products.

* * *

CHARLES J. LUCY is the new manager of market development of special products for *Corning Electronic Components*, a department of *Corning Glass Works*.

In his new post, Mr. Lucy will be responsible for the development of new products and markets for the firm's line of tin oxide resistors, trimmer capacitors, Fotoceram printed circuits, inductances, and ultrasonic delay lines.

He joined the company in 1952 as a research engineer and supervised the development of fused silica and ultrasonic delay lines. He holds a B.S. in electronic engineering from Massachusetts Institute of Technology.

* * *

WORLD RADIO LABORATORIES, Council Bluffs electronic distributing firm, recently celebrated its 25th Anniversary in the field with a reception and dinner tendered by *Radio Corporation of America*, whose products *WRL* has been handling for 23 of the 25 years.

Mr. K. B. Schaffer, sales manager for *RCA* distributor products, presented a plaque commemorating the event to Leo I. Meyerson, president of *WRL*.

* * *

GRAYSON MERRILL has been elected to the new corporate post of vice-president, electronics of *Harris-Intertype Corporation*.

A former U.S. Navy captain and first technical director of the Navy's "Polaris" program, Mr. Merrill has resigned as general manager of the Astrionics Division of *Fairchild Engine and Airplane Company* to assume his new position.

He will have corporate responsibility for the company's two electronics divisions, *PRD Electronics, Inc.* of Brooklyn and *Gates Radio Company* of Quincy, Illinois.

* * *

HOWARD W. SAMS & CO., INC. is building an ultra-modern, 200,000-square-foot building on a forty acre site at West 62nd and North Guion Road in Indianapolis to house all divisions of the firm. Completion is scheduled for March of next year. . . . **GULTON INDUSTRIES'** Alkaline Battery Division has moved from Lodi, N.J. to new consolidated headquarters at Metuchen, N.J. . . . **TITAN TRANSFORMER COMPANY** has moved into a new 12,000-square-foot manufacturing plant at 229 Binney Street, Cambridge, Mass. . . . **REFLECTONE ELECTRONICS, INC.** has begun operations in its new two-story

(*Continued on page* 89)

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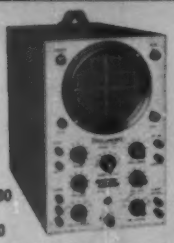

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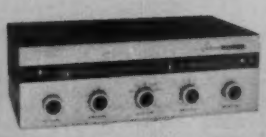

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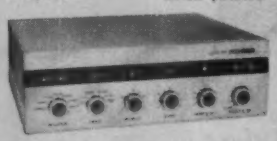

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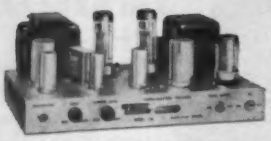

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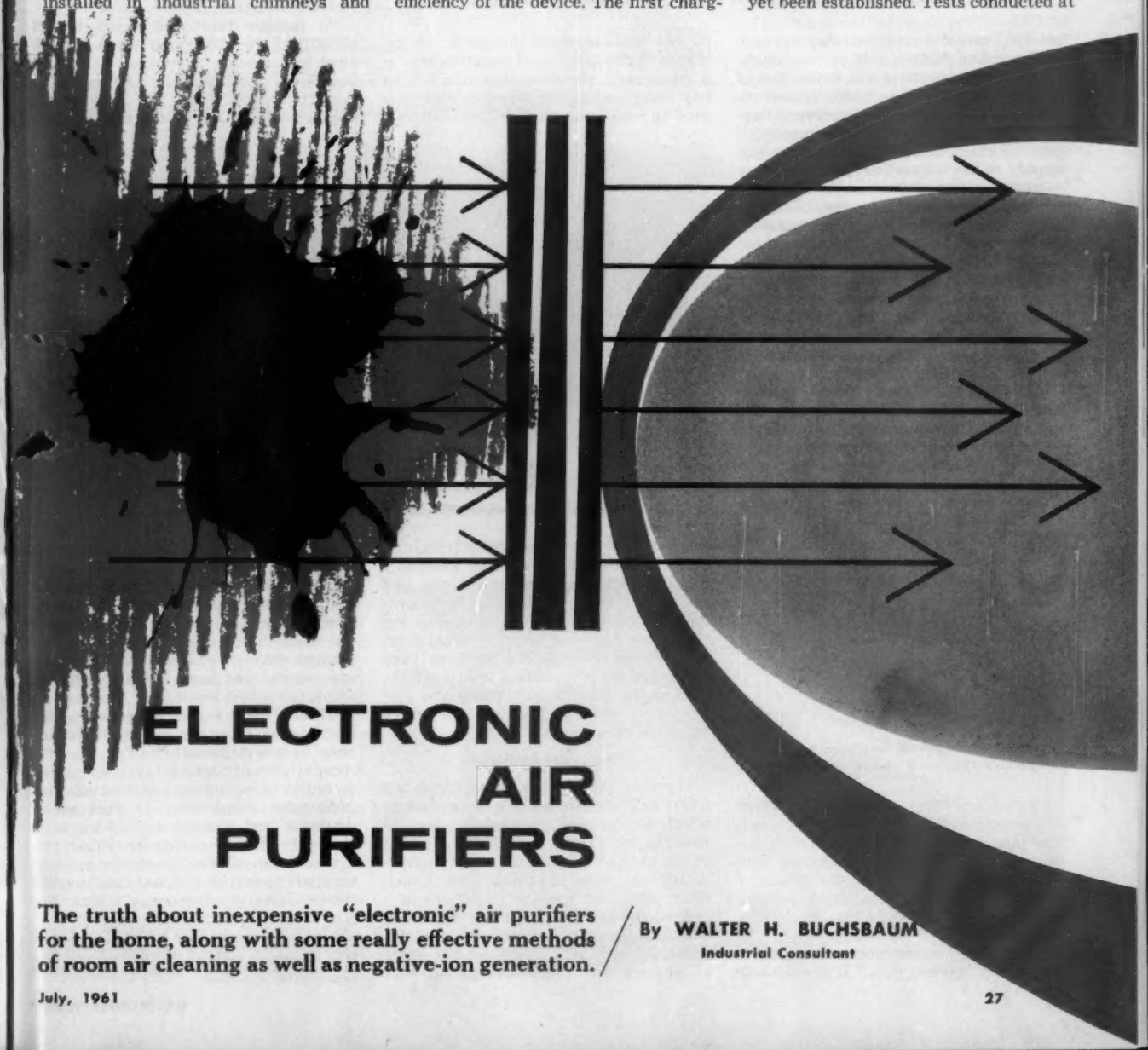


ELECTRONIC AIR PURIFIERS

The truth about inexpensive "electronic" air purifiers for the home, along with some really effective methods of room air cleaning as well as negative-ion generation.

By **WALTER H. BUCHSBAUM**
Industrial Consultant

RECENT articles in a number of consumer publications have called attention to a new type of appliance —the "electronic" air purifier. Many of our readers have been queried as to how and what electronics does to cleanse the air and how some of the advertising claims of the various manufacturers jibe with the actual facts. To answer these questions and to clear up some of the confusion about electronic air filters, negative ionization, ultraviolet "germ killing," and similar devices, we present here a factual account of the role electronics plays in air cleaning.

Electrostatic Precipitation

Every service technician has noticed that an unusual amount of dust tends to collect on the face of picture tubes. This is due to the electrostatic charge, resulting from voltages usually over 10 kv., which attracts dust particles to the tube glass. The same principle of electrostatic attraction is used in the precipitation devices which have long been installed in industrial chimneys and other places to collect dust particles. In many cities local ordinances require smoke producers to install such precipitation devices in order to keep air pollution to a bearable minimum.

Such a device is nothing more than a collection of electrostatically charged plates which attract particles from the air flowing between these plates. If the plates have a positive charge, only negatively charged particles are attracted to them while those particles which already contain a positive charge, or have no charge at all, would be carried along in the air stream. To attract as many particles as possible, they are usually first passed through an electrostatic field so that, when the air reaches the collector plates, all particles will have a charge of the opposite polarity and will be attracted to the plates.

A simple precipitation system is shown in Fig. 1. Note that grounded plates are located between the charged collector plates to concentrate the positive electrostatic field and increase the efficiency of the device. The first charging field is a thin wire located in the incoming air stream to generate a strong field without offering much surface to which particles could cling.

This system has several advantages over a mechanical filter, the foremost being its ability to collect very small particles which would pass right through a conventional filter. The second advantage is that electrostatic plates offer very little resistance to the air flow. A third advantage is the ease of cleaning the collector plates and the long life of the electrostatic filter.

Negative Ionization

Recent medical research has shown some relationship between the presence of negative ions in the air and human well-being. Ions exist in free air everywhere; some of these have a positive charge while others carry a negative charge. Some medical studies have shown that a preponderance of negative ions appears to be beneficial. Just how these negative ions benefit us has not yet been established. Tests conducted at

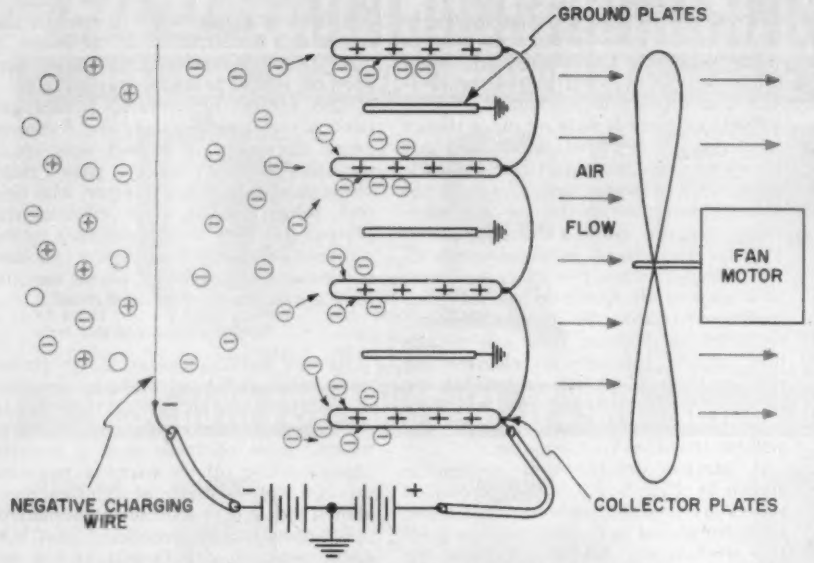


Fig. 1. Basic electrostatic precipitation system used in homes and in industry.

several medical institutions indicate that persons suffering from hay fever, asthma, nasal sensitivities, and a host of similar respiratory troubles appear to get some relief when the number of negative ions is greater than the number of positive ions. The effects of negative ions appear to be confined to the respiratory system, the heart, and the bloodstream. In general, breathing appears to be easier and the patient experiences a sense of well-being.

One theory points to a triggering action which the negative ions might have on increasing the oxygen content of the blood. Another theory has it that negative ions attach themselves to irritating particles, such as pollen, and produce some relief in the process.

At the time of writing there is no definite medical opinion and certainly no universally accepted clinical evidence concerning the benefits of negative ions.

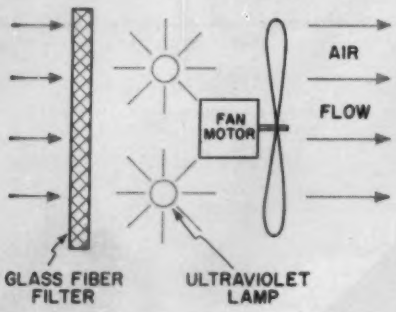


Fig. 2. Arrangement employed in inexpensive "electronic" home air purifiers.

As a matter of fact, some have criticized the experiments performed with negative ions as having limited validity because of the absence of adequate controls in the experiments, the difficulty in taking measurements and judging the effects, as well as psychological preconditioning both by the persons conducting the experiments and those serving as "guinea pigs." It is only safe to say that, in some instances, an increase in the number of negative ions in a room *may* alleviate discomfort from hay fever and pollen allergies and *may* tend to make the patient "feel better."

Ions are produced by an electrical discharge in the air. Lightning generally produces large quantities of ions and arcing or corona, being miniature lightning in effect, are therefore also ion producers. In commercial equipment, corona from negative high-voltage sources or simply a strong negative field, such as that used in an electrostatic precipitation system, produce the extra negative ions.

Ultraviolet Radiation

Many of the so-called "electronic air purifiers" contain ultraviolet lamps which are claimed to provide a host of benefits, including germ killing, filtering of the air and, according to some advertising copy, even the production of negative ions. The operating portions of a typical, inexpensive unit are shown in Fig. 2. Unless the Madison Avenue "inventors" have revolutionized the state of physics and medicine beyond that taught in universities, ultraviolet radiation does not generate negative ions directly nor does it have any filtering action.[1]

Ultraviolet radiation has a wavelength considerably shorter than that of visible light. When certain microorganisms are irradiated with ultraviolet light the effect is believed to be similar to that of "cooking" them. This effect has been used for many years to reduce food spoilage and improve the sterilization of toilets and other sanitary devices, but no claims have ever been supported by scientific data pointing to its effectiveness in air purification or negative-ion generation.

Present medical research, including recent extensive studies at the Rockefeller Institute, indicate that ultraviolet radiation does not kill typical virus cultures nor does it seem to affect a number of other microorganisms. There is no clinical proof that cold germs, a type of virus, have ever been killed or even retarded in their reproduction by ultraviolet irradiation.

To further limit the much touted benefits of the ultraviolet lamps used in most inexpensive "electronic" air purifiers, we should consider the length of time microorganisms are exposed in such a device. One of the most widely

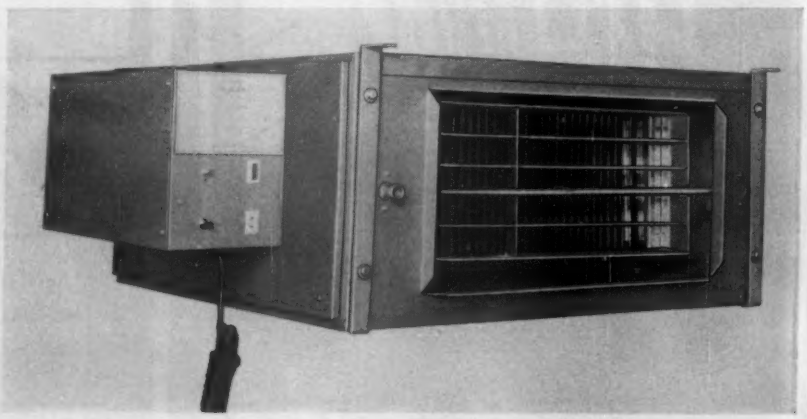


Fig. 3. Westinghouse "Precipitron" utilized for duct-type installations.

advertised "electronic" air purifiers has a capacity of about 15 cubic feet of air per minute. If we consider the internal space in which ultraviolet light irradiates the air stream to be approximately one cubic foot, any germs in the air stream moving at 15 cubic feet per minute are exposed to ultraviolet radiation for only about 4 seconds.

Clinical experiments conducted at the Rockefeller Institute indicate a killing time from 5 minutes to half an hour for most strains of bacteria, even when subjected to very intense and concentrated ultraviolet irradiation. It thus seems doubtful that the ultraviolet lamps in home air purifiers can do more than give a weak tan to the bacteria passing through. However, a lethal dose may hit those unhappy bacteria which are

[1] It is possible for ultraviolet radiation to produce negative ions indirectly by the use of negatively charged copper screening around an ultraviolet lamp. This screening is flash-plated with silver then gold. Electrons that are ejected from the metal produce negative ions.—Editors.

trapped in the mechanical filter—a component of most of these air purifiers.

To sum up, ultraviolet radiation does not contribute substantially to air purification nor to the production of negative ions. Inexpensive "electronic" air purifiers which feature a mechanical filter and ultraviolet lamps cannot provide very effective "electronic" air filtering.

Inexpensive "Electronic" Purifiers

Appliance stores, drug stores, and even supermarkets now sell inexpensive "electronic" home air purifiers which are promoted on the basis of their almost unbelievable benefits. This author has examined typical devices of this kind and after some tests has arrived at the following conclusions.

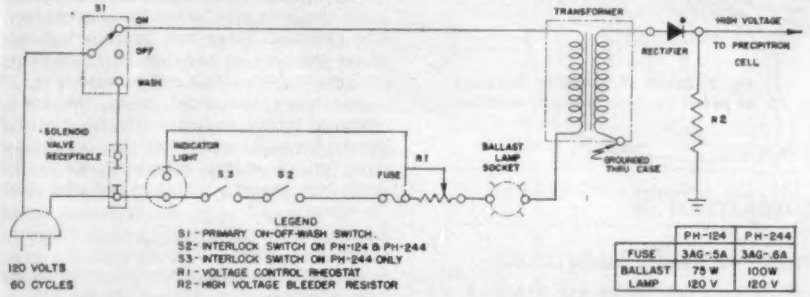
If ultraviolet lamps are considered an electronic device, then fluorescent lights should also be so labeled and we should be proud of our kitchens, homes, and offices with their "electronic" lighting. In the accepted meaning of the word "electronic," however, these particular home air purifiers do not qualify as "electronic devices."

Some definite benefits are obtained from such home air purifiers, which usually include one or two small ultraviolet lamps, a mechanical dust filter, and a small circulating fan. First, the ultraviolet lamps, in addition to the ultraviolet radiation, also produce a small amount of ozone. This serves as a deodorizer. There are some, however, who may find the slight smell of ozone a little disagreeable. (These lamps, by the way, are similar to the types sometimes used in home dryers to impart a fresh smell to the family laundry during drying.)

A second benefit is that the air is passed through a mechanical dust filter. This is the same type of glass fiber dust filter used in air conditioners and is quite effective in trapping large dust particles, dirt, and the larger particles in tobacco smoke. If this filter is cleaned frequently, its use will result in a reduction of common household dust and will, to that extent, purify the air. The use of a fan further helps in creating the effect of purer air in a room because the fan tends to homogenize and circulate the otherwise stale air. Fine particles of smoke and dust are mixed into the air so as to avoid their concentration. This helps in many instances to create the feeling that the air is fresh and pure.

The third major advantage is purely psychological. The presence of an air purifier which has been advertised as providing great benefits, coupled with the reassuring purr of the fan and the motion of air, often gives hay fever sufferers the feeling that something is being done to alleviate their misery and therefore tends to minimize the symptoms of their actual allergy. It is a well-known medical fact that many allergies are based on psychological rather than physiological grounds.

Now, let's consider the truly electronic and really effective air purifiers which are currently available for use in the home.



	PH-124	PH-244
FUSE	3AG-.5A	3AG-.6A
BALLAST LAMP	75 W 120 V	100W 120 V

Fig. 4. Circuit of "Precipitron" showing use of step-up transformer and rectifier.

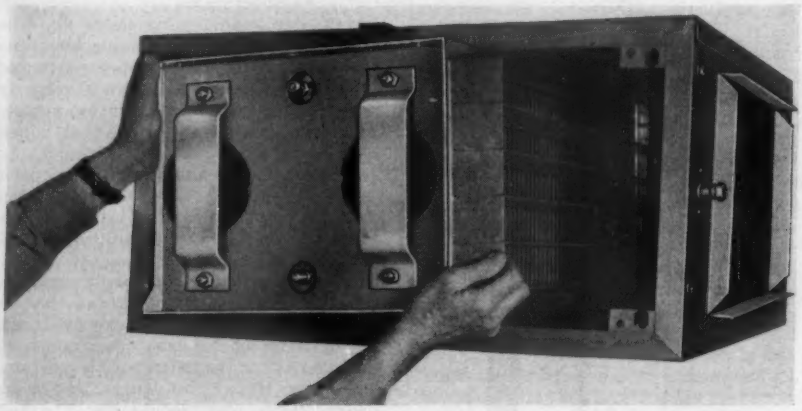


Fig. 5. Removal of the collector-plate assembly in the "Precipitron" unit.

Effective Air Purification

Regular room air conditioners provide a surprisingly efficient degree of air purification. During the summer, when high humidity requires the use of air conditioners, the removal of moisture itself eliminates a very large percentage of pollen and other small particles which are trapped by the moisture. The mechanical air filter, with which all air conditioners are equipped, further aids in the reduction of household dust. The one shortcoming of air conditioners is that they will not really eliminate stale air or rather the components of stale air such as gases, which cause the unpleasant odors, or the small particles of tobacco smoke which, in a recirculating air conditioning system, become distributed within the room and eventually cause irritation of the eyes and nose.

The most efficient way to air condition a house is to do it with a ducted system which keeps the entire structure at the desired temperature and humidity. In many modern homes this same system of ducts is used in the winter to heat the house. Such a duct system offers the ideal place in which to install an electronic precipitation system.

Among the currently available units, *Westinghouse* offers two models of its "Precipitron" which are especially designed for installation in the heating

Fig. 6. The Emerson "Ionator" electrostatic air purifier and negative ionizer.

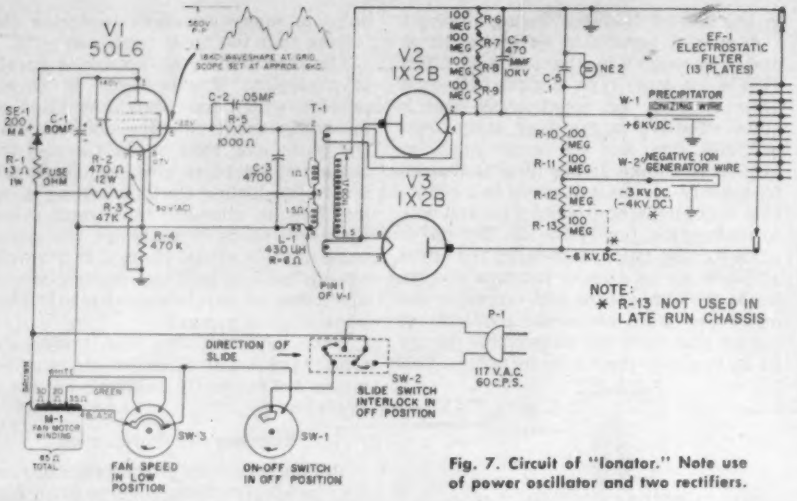


Fig. 7. Circuit of "Ionator." Note use of power oscillator and two rectifiers.

and air conditioning duct system. Such a device, properly installed, will reduce house dust dramatically. It will also tend to collect such small particles as pollen, bacteria, and even some types of virus. It is a good way to produce pure air, summer and winter. Fig. 3 shows the *Westinghouse* Model PH-124 which is designed with sufficient capacity to service a 6-7 room house. This unit contains, as a special built-in feature, a connection for water inlet and drain so that the collector plates can be cleaned periodically with hot water. An optional feature includes an automatic solenoid valve which is turned on at intervals to clean the filters automatically. To get an idea of the circuitry involved, Fig. 4 is a schematic diagram of the *Westinghouse* "Precipitron." Note that the voltage is obtained from a 60-cycle transformer and a selenium rectifier. The collector plate assembly itself is shown in the photo of Fig. 5. Different models, to accommodate different ducting and provide different capacities, are available.

For those seeking the advantages of a precipitation system without installing it in the duct system, *Emerson* provides a reasonably priced model. Fig. 6 shows this firm's "Ionator" which combines a precipitation system with a negative-ion generator. The circuit of Fig. 7 indicates that the high voltage required for the system and for the ion generator is obtained from an r.f. power supply reminiscent of the high-voltage power supplies in some early TV receivers. The 50L6 power tube is connected as an 18-kc. oscillator and provides high-voltage power to two 1X2B rectifier tubes. Plus 6 kv. is used for the wire which charges the ions before they enter into the electrostatic filter. The filter plates themselves are connected to the −6 kv. source. This polarity has been adopted so that negatively charged ions will not be trapped by the negatively charged filter. To add to the supply of negative ions in the room, a −3 kv. negative-ion generator is installed in the air flow after the electrostatic filter. The *Emerson* unit also contains a mechanical filter, as can be seen in the

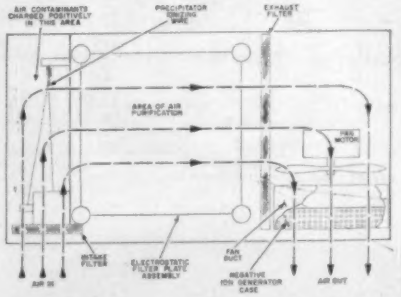


Fig. 8. Air-flow diagram of the "Ionator."

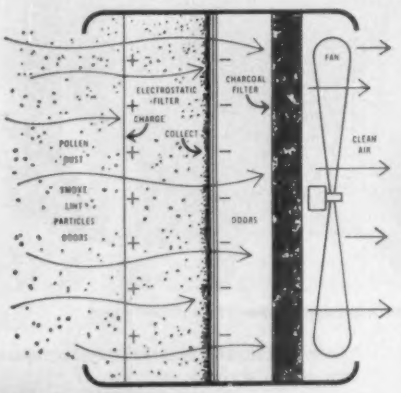


Fig. 9. Air flow of the Honeywell unit.

block diagram of Fig. 8 which shows the over-all air flow of this unit. Aside from the interesting electronic circuitry of this unit, the "Ionator" has been found to be extremely effective.

A source of negative ions is also included as an optional feature in some models of *Philco* air conditioners. The "Ionatron" is a complete system which can be installed on every 1960 *Philco* air conditioner as well as on some of the 1958 and 1959 models.

As previously stated, a true precipitation system can filter out even very small particles, but it cannot remove gases from the air. To take care of such odors, a chemical filter may be used. Most offensive odors are due to gases, such as sulphur dioxide, and activated charcoal filters have the ability to "trap" these gases chemically. Some recent models of air purifiers, designed for kitchen range hoods, include charcoal filters and/or ozone-producing ultraviolet lamps and may, therefore, be effective in removing some kitchen odors.

As of now, only the *Minneapolis Honeywell* "Electronic Air Cleaner" combines the precipitation system with an activated charcoal filter, as shown in Fig. 9. Air is first cleaned by precipitation and then pulled through the charcoal filter. This is a portable unit which opens like a suitcase to permit replacement of the charcoal filter and cleaning of the collector plates. See Fig. 10. When only the precipitation action is required, the charcoal filter can be removed and then the fan is capable of circulating 150 cubic feet of air per minute. Fig. 10 also shows the location of the high-voltage power supply with the rectifier cartridge and bleeder resistor just below the fan. A safety interlock opens the primary power circuit when the case is opened.

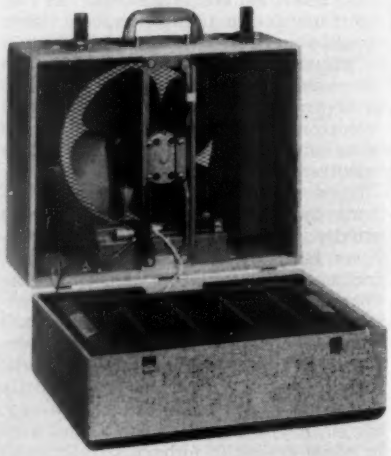
Conclusion

To the factual material concerning air purifiers, the author would like to add the results of an informal poll he recently conducted among eight electronic engineers who are hay fever sufferers. Air conditioning helps six who suffer from allergies to plants blooming in the summer. All eight experienced various degrees of relief in a room in which an effective precipitation system had been operating for several hours. One reported that, surprisingly, he found relief with one of the inexpensive pseudo-electronic devices. The other seven promptly classified him as a neurotic whose allergy was only imagined, at best.

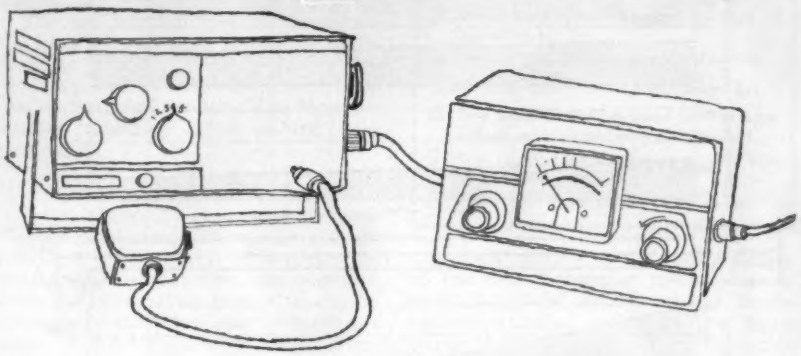
If any conclusion can be drawn from this little survey, it might be that an effective precipitation device will definitely help in the case of airborne allergies. As for the benefits of a mechanical filter, ultraviolet lamps, and a fan —try them and decide for yourself.

-30-

Fig. 10. The Honeywell air cleaner is shown here with its case opened



IMPEDANCE MATCHING CB ANTENNAS



By **HARTLAND B. SMITH,** 19W1375

Don't waste power by mismatching your CB transceiver. Here are practical suggestions for improving performance.

THE FCC's five-watt input restriction places a premium on CB equipment performance. Unless your mobile and base station transceivers and antenna systems are all working at peak efficiency, the communication range will be seriously restricted. A knowledge of transmission-line theory and antenna-matching procedures can be very helpful to the CB operator who seeks top-notch results.

The most convenient location for a transceiver is seldom a good place for an antenna. Consequently, these two items are usually interconnected with an r.f. transmission line, an undesirable parasite which contributes nothing to the signal. As a matter of fact, no matter how well a line is constructed, a measurable amount of the power which is fed into one end never reaches the other. This power loss is caused mainly by the series resistance of the two conductors which make up the line and by the leakage resistance of the insulation between them. Obviously, it pays to use as short a feeder as possible, in order to minimize power waste.

Solid dielectric coaxial cable is most often chosen for CB installations. Less efficient than twin-lead or open-wire line, coax is preferred because it provides shielding, has little radiation loss, and is more convenient to work with. Coax may be buried in the ground, run through metallic conduit, or taped to a steel mast without affecting its electrical characteristics.

Although CB transceivers are usually designed to work into 52-ohm cable, 75-ohm coax may be used if the antenna has a feedpoint resistance of this value.

Impedance Matching

The impedance rating of coaxial cable is determined by the ratio between the inside diameter of the shield and the outside diameter of the inner conductor. Thus, two cables, one thick and the other thin, may have exactly the same characteristic impedance. However, in order to maintain the correct diameter ratios, the center conductor of the thin cable must be much finer than the center conductor of the thick cable. Resistive losses, therefore, are greater in the thin cable than in the thick one. Whether you decide to purchase light or heavy coax depends on how much money you wish to spend and upon how much loss can be tolerated at your particular installation. The characteristics of four popular cables are given in Table 1 to help you make a suitable choice.

Maximum transmission efficiency occurs when a pure resistance is connected across the antenna end of the coax which matches the impedance of the cable. (This assumes that the output impedance of a CB rig is purely resistive.) 52-ohm cable, for example, requires a 52-ohm terminating resistance while 75-ohm cable works best with a 75-ohm resistance.

Fig. 1 graphically shows how line loss is increased by improper termination. In Fig. 1A a CB transceiver with 3 watts output is connected to 100 feet of RG-58/U cable which is terminated by a non-reactive composition resistor. A composition resistor is employed because, unlike a wirewound unit, it has practically no inductance or distributed capacity. For our purpose, it may be considered as a pure resistance. Under the matched condition depicted in Fig. 1A, 1.94 watts of r.f. power reach the resistor. The balance of the transceiver's output is swallowed up by the cable.

A drooping ground-plane antenna has a feedpoint resistance of 50 to 55 ohms. If a 27-mc. antenna of this type is connected to the cable in place of the 53.5-ohm resistor, the curves of Fig. 1A will remain substantially unchanged.

In Fig. 1B, a 267.5-ohm terminating resistor is used. Since 267.5 ohms is five times the characteristic impedance of the cable, the line is no longer correctly terminated. As a result of this 5 to 1 mismatch, some of the energy which reaches the resistor is reflected back toward the transceiver. When the reflected energy arrives at the transceiver end of the cable, it joins with new power being supplied by the transceiver and returns to the resistor. Each time reflected energy traverses the feedline it must overcome the loss resistance of the cable. In the process, a significant amount of power is wasted. As a matter of fact, in Fig. 1B only 1.31 watts are available at the resistor. More than half of the transceiver's output, 1.69 watts, is wasted in the feedline because of the extra trips made back and forth by the travelling wave of reflected energy.

Fig. 1B shows what happens when the right transmission line is hooked to the wrong antenna. The situation depicted is approximately equivalent to using 53.5-ohm coax to feed a 27-mc. folded dipole (Fig. 3D). Often employed by radio amateurs, the folded dipole is not recommended for CB use because it is incompatible with coax.

In Fig. 1C the terminating resistance is only 10.7 ohms. Line losses are the same as in the previous example, because the ratio between the line impedance and the terminating resistance is again 5 to 1. A mismatch of this magnitude will occur if coax is connected directly to the driven element of a beam antenna (Fig. 3F) instead of through some form of impedance-matching device.

The current and voltage curves of Fig. 1A are smooth. Although there is a slope to the right denoting a power loss, no undulations or peaks and valleys are visible. The standing-wave ratio (s.w.r.), which is the ratio between a voltage or current maximum value to an adjacent minimum value, is, therefore, said to be 1 to 1.

In Figs. 1B and 1C the voltage and current curves show rather large fluctuations. The maximum values or peaks, more correctly referred to as loops, are 5 times as high as the adjacent troughs, or nodes. The s.w.r. is 5 to 1.

The power curves of Figs. 1B and 1C

Table 1. Power losses for the most commonly used coaxial cables when properly matched and when mismatched by 5 to 1. See text.

TYPE	CHARAC. IMP. (ohms)	DIA.	PWR. LOSS/100′ (27 mc., 1:1 s.w.r.)	PWR. LOSS/100′ (27 mc., 5:1 s.w.r.)	COST (100 ft.)
RG-8/U	52	.405″	19.75%	38.4%	$11.90
RG-11/U	75	.405″	18.75%	36.9%	$11.00
RG-58/U	53.5	.195″	35.4%	56.4%	$ 4.90
RG-59/U	73	.242″	35.4%	56.4%	$ 5.10

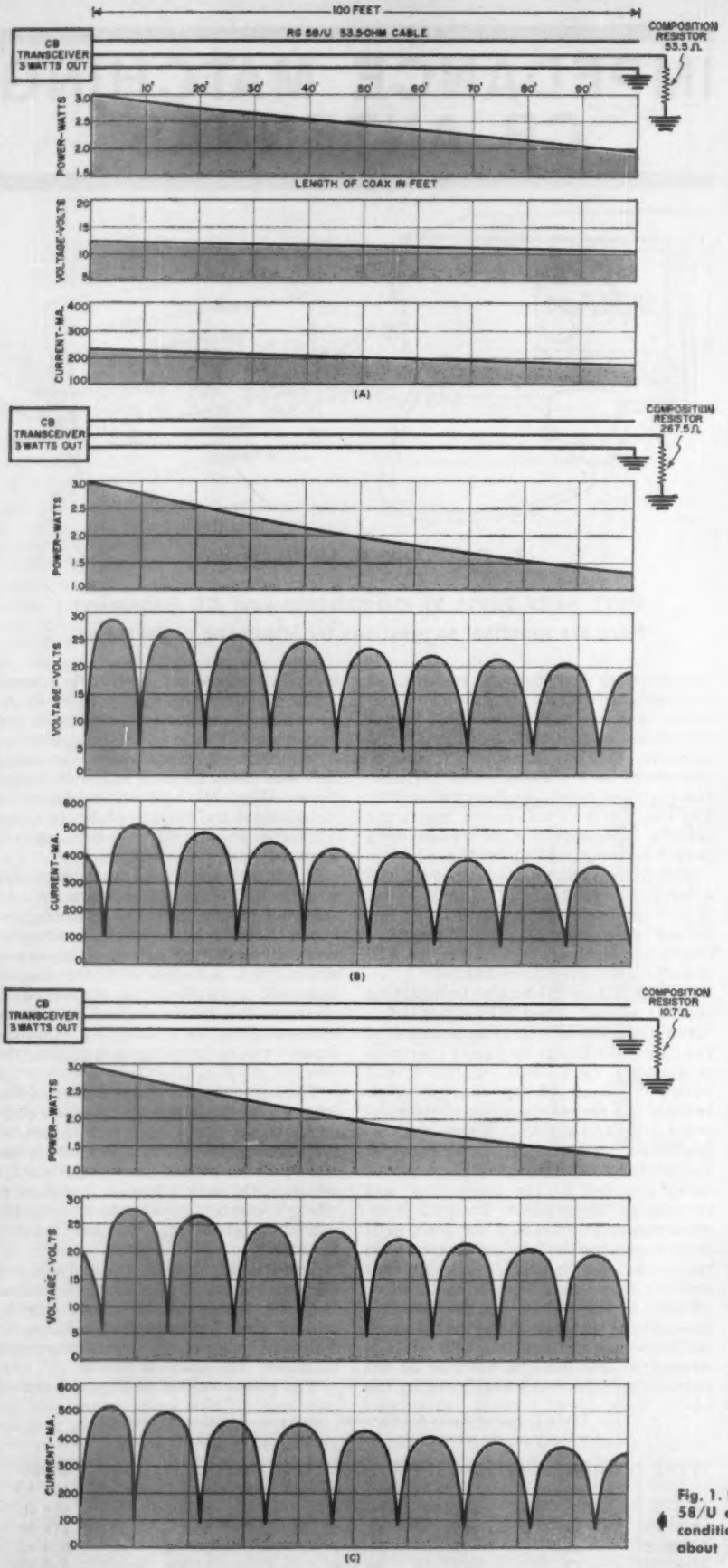


Fig. 1. Power, voltage, and current along RG-58/U coax under matched and mismatched conditions. A wavelength on this line is about two-thirds of its free-space length.

are drawn smooth, despite the 5 to 1 s.w.r., because the voltage and current excursions cancel each other. When the current is up the voltage is down and *vice versa*.

Standing Waves

The standing-wave concept isn't an easy one to grasp. Radio waves travel along a coaxial cable at approximately two-thirds the speed of light. For this reason it is rather difficult to visualize how something can stand still while traveling so rapidly. Nevertheless, standing waves are very real. So real, in fact, that you can actually feel their effect. A badly mismatched cable, when carrying an appreciable amount of power, will become hot enough to melt the insulation at the high current points. Yet at the current nodes, the cable will hardly be warm to the touch.

Many have the mistaken notion that a standing wave is a radio wave that has come to a screeching halt. This, of course, is not true. Radio waves move just as rapidly in a cable plagued with standing waves as in a cable blessed with a 1 to 1 s.w.r. When someone speaks of standing waves he is merely referring to the variations in meter readings which can be detected as an r.f. voltmeter or ammeter is moved along an improperly terminated line, as graphically portrayed in the curves of Figs. 1B and 1C. These undulations are caused by the reflected energy which alternately bucks and reinforces the new energy emerging from the transceiver. A careful study of Fig. 2 will disclose how this process takes place.

In this highly imaginative sketch a transmitter is shown generating alternately positive and negative 3-volt charges which flow into a 53.5-ohm cable of infinite length. At the left of the transmitter is a clock. While the action depicted in Figs. 2A through 2E takes place, the clock hand rotates once, charges *A*, *B*, *C*, and *D* move steadily to the right and two new charges, *E* and *F*, are generated. The needle of a non-polarized, peak-reading voltmeter placed on the cable at any position between I and VII will be deflected to 3 by the passing charges. There are no standing waves on the coax, but all the waves are traveling steadily from left to right.

In Fig. 2F a short piece of cable is terminated with a pure resistance of 53.5 ohms. As far as the transmitter is concerned, the cable still appears as though it were infinitely long. There are no standing waves because all of the energy reaching the end of the coax is absorbed by the resistor.

At 2G, however, the resistor has been removed, leaving an open circuit. Water may flow from the end of a pipe, but electrical energy isn't likely to fall off the end of a wire. Consequently, when charge *A* reaches position VIII, it rebounds like a rubber ball from a brick

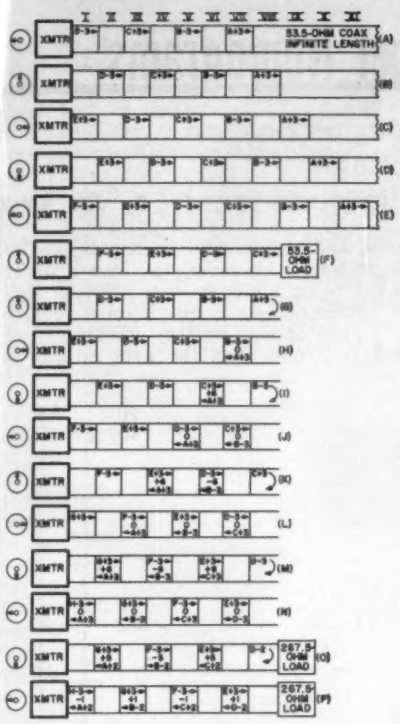


Fig. 2. Standing waves occur when outgoing energy is re-inforced or cancelled by the energy that is reflected back along line.

wall and starts back toward the transmitter. On its return trip, whenever charge *A* encounters another positive 3-volt charge, the two add to create a 6-volt potential. Where *A* coincides with a negative 3-volt charge, cancellation takes place and the resulting voltage is zero.

By the time *A* has arrived back at the transmitter (Fig. 2N) all outgoing charges are bumping into reflected charges. There are now standing waves on the line. The voltmeter will always read 6 when placed at position II, IV or, VI because, whenever two charges meet at these points, they are of the same polarity and so their sum is 6. This is not true at I, III, V, and VII, where the meter will read zero, because charges of unlike polarity always pass each other at these positions. The s.w.r. is 6 to 0, an infinitely high figure.

In Figs. 2O and 2P a resistor of the wrong value terminates the line. The reflected charges have a potential of only 2 volts, since some of their energy is absorbed and dissipated by the resistor. When the returning 2-volt charges encounter outgoing 3-volt charges, they add to 5 or drop to 1, producing a 5 to 1 s.w.r.

If either capacity or inductance is associated with the terminating resistor, the s.w.r. on a transmission line will rise sharply, even though the resistor itself may closely match the line. When an antenna is too long or too short for the operating frequency, it exhibits inductance or capacity, as well as resistance. Thus, it acts as an impure resistance and boosts the s.w.r. Low line losses cannot be achieved unless the antenna is accurately resonated at the operating frequency. The dimensions and feedpoint resistance shown in Fig. 3 will be affected to some extent by height above ground, the proximity of other objects, and the size and type of material used in construction. Therefore, it is always a good idea to check a new antenna system with suitable test equipment to learn whether or not it is correctly tuned.

The best location for a mobile antenna, from the viewpoint of best performance, is usually in the center of the vehicle's roof. A fairly good spot is on one of the front fenders. The least desirable mounting place is the rear bumper.

Checking S.W.R.

Use a 52- or 53.5-ohm cable for your mobile installation. Since only a short length of coax is required between the whip and the transceiver, loss resulting from the terminating mismatch will be small if you employ a quarter-wave antenna. A quarter-wave whip should not be pruned in an attempt to improve performance. However, a coil-loaded vertical or a spiral-wound Fiberglas whip, one that's physically shorter than a quarter wave, may do a more efficient job if it is carefully adjusted for minimum s.w.r. as indicated on a reflected-power meter. Instruments suitable for making the necessary measurements include the *Globe* TM-1, *Cesco* CM-52, the *Heath* AM-2, and others. The procedure which follows applies specifically to the AM-2. When using a different brand of meter, follow the instruction manual supplied by the manufacturer.

Disconnect the coax from the transceiver and place it in the output socket of the reflected-power meter. Run a short length of coax from the transceiver's antenna socket to the input terminal of the meter. If the cable fittings of the transceiver and meter do not mate, you can obtain adapters from your electronics parts dealer.

Set the meter's function switch to "Forward." Turn on the transceiver and adjust the sensitivity control for a full-scale meter reading. Some transceivers may not put out enough power to move the meter to full scale, even with the sensitivity control fully advanced. Although this will cause the s.w.r. reading to be over optimistic, it is of little consequence, since we are more interested in achieving the lowest possible s.w.r. than in knowing the precise value of s.w.r.

(*Continued on page* 96)

SUGGESTIONS FOR IMPROVING PERFORMANCE OF YOUR CB SYSTEM

1. Mount mobile antenna on roof or front fender of vehicle, if possible.
2. Prune or telescope coil-loaded short whip for lowest s.w.r.
3. Mount base-station antenna as high as law allows.
4. Use shortest possible transmission line.
5. Maintain base-station s.w.r. below 2:1.
6. Tune transmitter final stage for maximum output, without exceeding legal limit.
7. Peak receiver input stage to provide best weak-signal response.
8. Avoid cross-polarization of antennas.

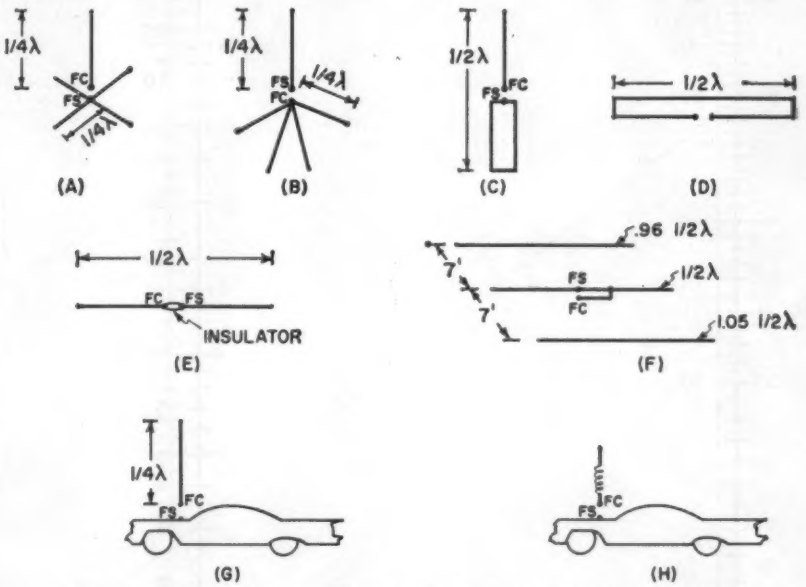


Fig. 3. A number of popular CB antennas. In all cases, ¼λ = 8'8" and ½λ = 17'4". FC is feed point for coax center conductor and FS is feed point for coax shield. (A) Ground plane, about 35 ohms impedance (52 ohms with built-in matching arrangement). (B) Drooping ground plane, about 52 ohms impedance. (C) Coaxial vertical, about 72 ohms. (D) Folded dipole, about 280 ohms. (E) Dipole, about 72 ohms. (F) Three-element beam, under 30 ohms (52 ohms with built-in matching arrangement shown). (G) Mobile whip, about 35 ohms. (H) Coil-loaded short mobile whip antenna, less than 30 ohms impedance unless it utilizes a built-in matching circuit.

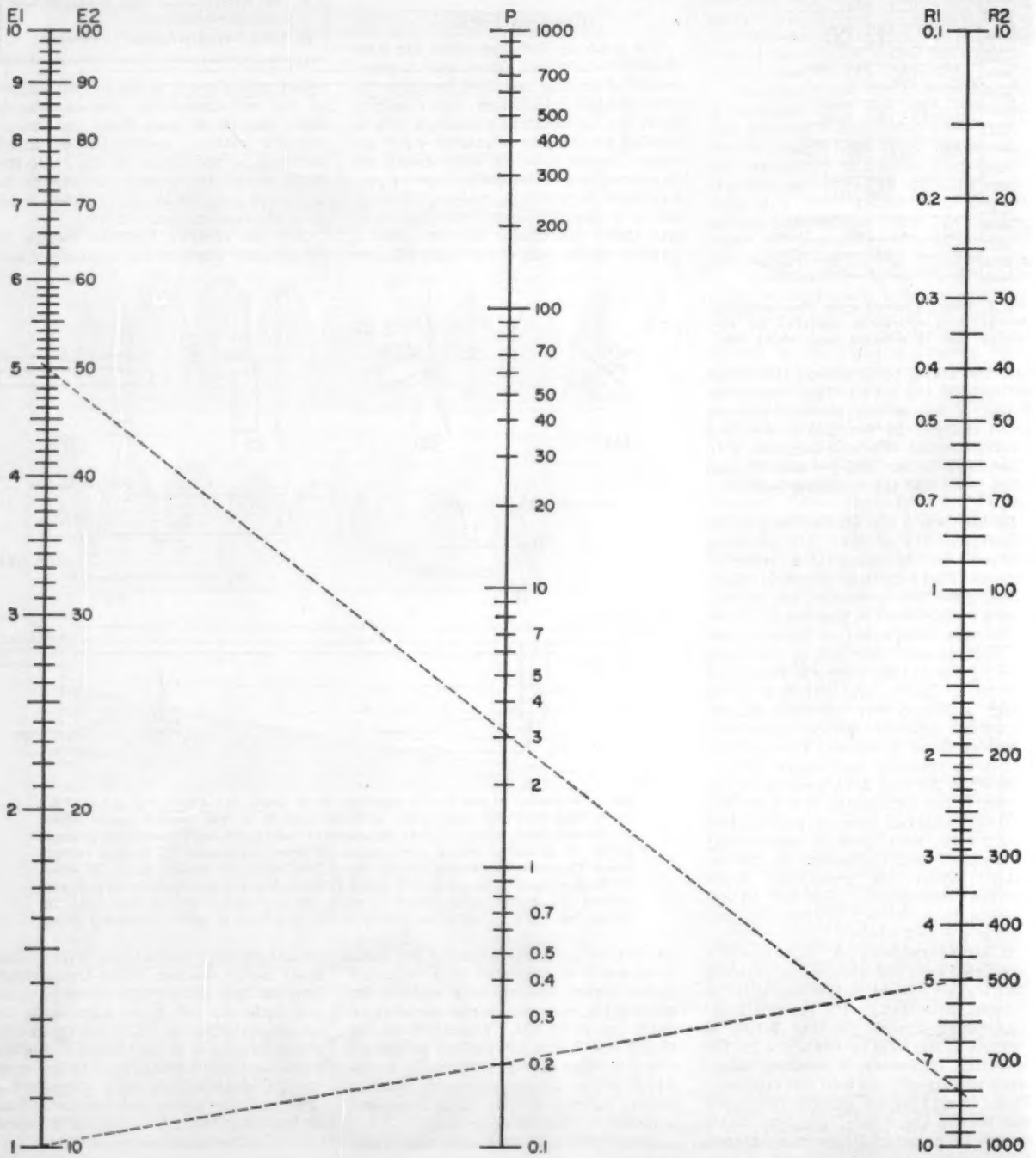
Versatile Voltage, Power, and Decibel Nomograms

Two useful charts that enable the audio technician to find amplifier gains and losses even when voltage measurements are taken across different impedances.

By JIM KYLE

CALCULATIONS of power levels and decibel ratios from voltage readings often lead to confusion for both experienced technicians and beginners, since the conventional formula for determining decibel ratio from voltage readings assumes that each reading is taken at the same impedance level.

Many charts, tables, and graphs have been published to aid in solving such problems. However, the charts shown here offer features not to be found in such previous aids. With it, the power corresponding to any voltage reading can be determined if resistance is known, voltage can be determined if power is known, and the gain or loss in



decibels of any equipment can be determined if input and output voltages and resistance can be measured. The charts cover a power range of 10,000 to 1, a voltage range of 100 to 1, and the decibel range from +40 to −40.

Chart 1 (at the left) is used for voltage-power-resistance calculations. Chart 2 (below) converts power levels directly to decibels gain or loss.

The voltage and resistance scales of Chart 1 bear two sets of graduations, labeled *E1* and *R1* and *E2* and *R2* respectively. Scales bearing the same suffix number are used together.

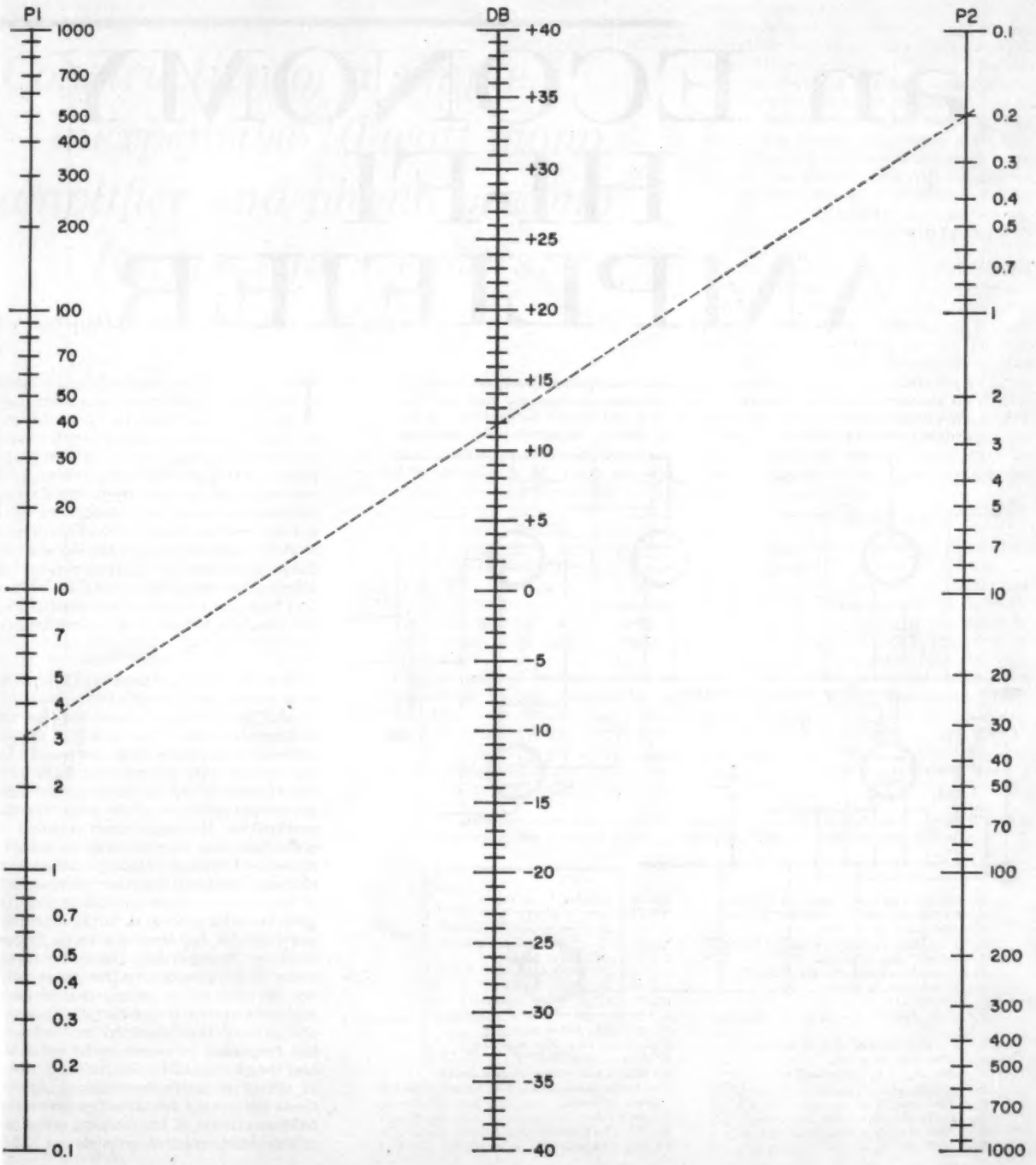
In use, known or measured values are located on the appropriate scales and a straight line is drawn across all three scales connecting the two known points. The unknown value is read off its scale at the intersection of the scale and the plotted line.

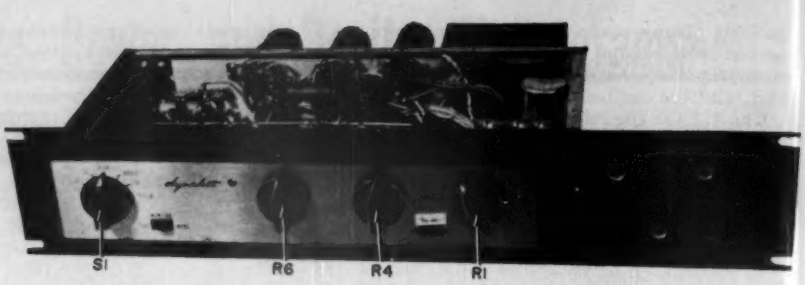
For example, suppose an amplifier is under test. A 10-volt signal applied to the 500-ohm input produces an output measured at 5 volts across 8 ohms. A problem such as this is usually tricky if the standard formula is hastily (and incorrectly) applied to yield a "gain" of −6 db. Let's see what the chart says:

First, determine input power from Chart 1. The line connecting 10 volts (*E2* scale) and 500 ohms (*R2* scale) passes through 0.2 watt.

Output power is next. This time, the *E1* and *R1* scales of Chart 1 are used, yielding an answer of 3.1 watts.

Now we turn to Chart 2. Connecting the 3.1-watt output (*P1* scale) and the 0.2-watt input (*P2* scale) gives a total amplifier gain of just under 12 decibels. The whole business is as simple as that! With a little practice you can make these calculations with both speed and accuracy. —30—

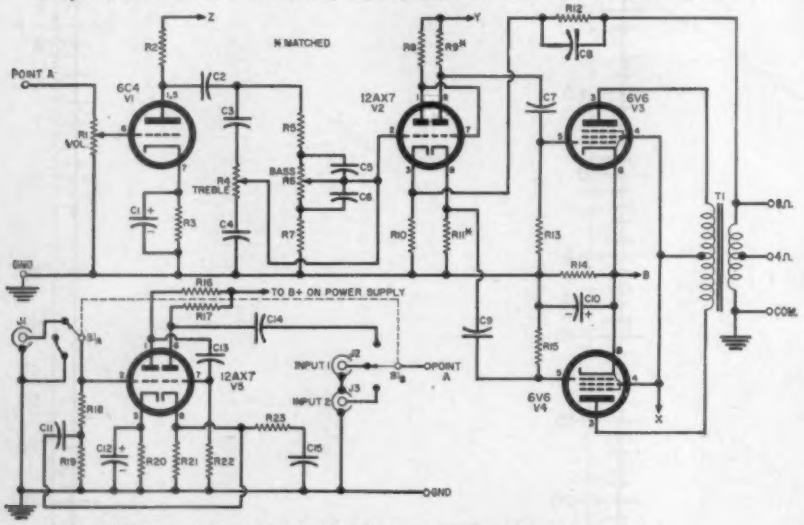




The amplifier was built on the back of a 3" high expandable chassis. The front panel is a piece of 3½" aluminum rack panel, finished in black wrinkle enamel, with a brass escutcheon plate from a commercial preamp used to dress it up.

an ECONOMY HI-FI AMPLIFIER

Fig. 1. The phono preamp, shown directly below the amplifier circuit, was designed for use with a G-E mono pickup. If other magnetic cartridges are used and their characteristics differ considerably from the G-E unit, it will be necessary to experiment with the values of R_{18}, R_{19}, R_{21}, C_{11}, and C_{15} to obtain a flat response.



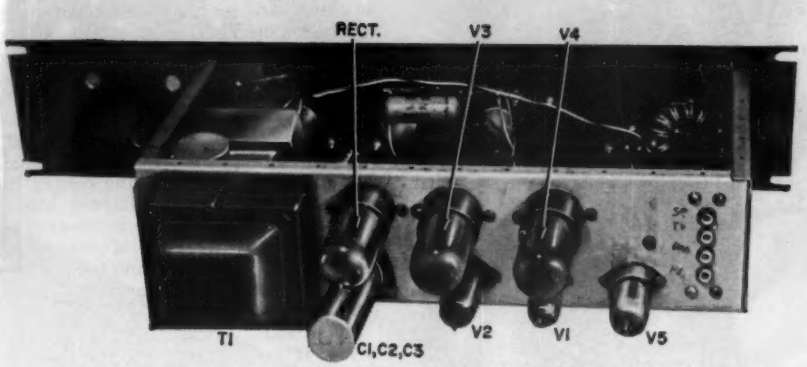
R_1—500,000 ohm audio taper pot ("Volume")
R_2, R_{17}—47,000 ohm, ½ w. res.
R_3—1000 ohm, ½ w. res.
R_4—1 megohm audio taper pot ("Treble")
R_5—100,000 ohm, ½ w. res.
R_6—1 megohm audio taper pot ("Bass")
R_7—12,000 ohm, ½ w. res.
R_8—330,000 ohm, ½ w. res.
R_9*, R_{11}*—150,000 ohm, ½ w. res. (matched pair)
R_{10}, R_{13}, R_{16}—470,000 ohm, ½ w. res.
R_{12}—4700 ohm, ½ w. res.
R_{14}—250 ohm, 5 w. wirewound res.
R_{15}—150,000 ohm, ½ w. res.
R_{18}—3900 ohm, ½ w. res.
R_{19}—1 megohm, ½ w. res.
R_{20}—2200 ohm, ½ w. res.
R_{21}—1500 ohm, ½ w. res.
R_{22}—2.2 megohm, ½ w. res.
R_{23}—220 ohm, ½ w. res.
C_1, C_{12}—50 μf., 12 v. elec. capacitor
C_2, C_{11}, C_{15}—.25 μf., 400 v. capacitor
C_3—750 μμf., 400 v. capacitor
C_4—.005 μf., 400 v. capacitor
C_5—.002 μf., 400 v. capacitor
C_6, C_{13}—.01 μf., 400 v. capacitor
C_7, C_8, C_{14}—.05 μf., 400 v. capacitor
C_9—270 μμf., 400 v. capacitor
C_{10}—25 μf., 50 v. elec. capacitor
J_1, J_2, J_3—Phono jack
S_1—D.p. 3-pos. rotary selector switch
T_1—Audio output trans. 3000 ohms c.t. to 4/8 ohms, 10 watts
V_1—6C4 tube
V_2, V_5—12AX7 tube
V_3, V_4—6V6 tube

THE amplifier to be described was designed for use with a bookshelf loudspeaker enclosure and record changer to form a compact high-fidelity system. Its output power, 10 watts, may seem a bit puny by today's standards, but when we consider that with a small, efficient loudspeaker system one watt is sufficient to produce a sound intensity that is uncomfortably loud, we see that there is plenty of reserve power. An integral preamplifier provides volume and tone controls as well as equalization for the RIAA recording characteristic.

The Circuit

The output stage uses a pair of 6V6's in a push-pull class A configuration. A 12AX7 is used as a phase splitter and voltage amplifier. The split-load type of inverter was chosen in preference to the paraphase type because the balance is determined by the load resistors and not by the parameters of the tube. The distortion in the split-load inverter is quite low due to the large amount of negative feedback from the unbypassed cathode resistor. Another consequence of the large cathode resistor is that the grid must be held at a fairly high voltage in order for the tube to be in conduction. This permits the driver stage to be direct-coupled to the phase splitter. In addition to saving two resistors and a capacitor, direct-coupling permits the gain of the driver to be increased, the frequency response to be extended, and the phase-shift to be reduced. About 12 db of negative feedback is applied from the output transformer secondary to the cathode of the voltage amplifier.

The bass control provides a 12-db



Rear view of the completed amplifier showing the tube layout and power transformer.

Construction of a simple, inexpensive 10-watt mono amplifier and phono preamp for efficient speakers.

By **ARTHUR GLASER** / Polarad Electronics Corp.

boost and a 20-db cut at 50 cycles while the treble control provides an 8-db boost and 15-db cut at 10,000 cycles. In order to be effective, this type of circuit must be driven by a low-impedance source. A 6C4 medium-mu triode voltage amplifier was chosen in preference to a cathode-follower because the output impedance, which is about 10,000 ohms, is low enough to permit proper operation of the tone controls. In addition, it provides a voltage gain which the cathode-follower cannot provide.

An input signal of 0.56 volt at the grid of this stage will drive the amplifier to its full ten-watt output. Most tuners and other high-level sources will supply about one volt, permitting the volume control and input selector switch to be placed in the grid circuit of this stage.

If a high-output phonograph pickup is used, it can be fed into one of the high-level inputs. If it is desired to use a magnetic pickup, it will be necessary to build a phono preamp. A high-mu twin-triode provides the necessary gain to increase the signal level of the pickup and to make up for the insertion loss of the equalizer.

The amplifier is powered by a transformer-operated supply. A full-wave vacuum rectifier and a capacitor input filter provide the necessary "B+" voltages. Series resistors are used in the power-supply filter, rather than chokes, because the voltage drop due to the quiescent current can be tolerated and a considerable saving in both space and cost can thus be realized. In order to reduce hum due to the a.c. on the heaters, a d.c. potential of 20 volts is applied to the heater circuit from the cathodes of the two 6V6 power-output tubes.

Construction

In an effort to reduce the size of the completed amplifier, the unit was built on the back of a 3-inch high chassis. Wiring the major portion of the circuit on the back of the chassis can be quite inconvenient, so a "SeeZak" expandable chassis was used. This permitted the wiring to be done before the chassis was assembled. The front panel is a piece of 3½-inch aluminum rack panel finished in black wrinkle enamel, with a brass escutcheon plate from a commercial preamplifier.

A common ground bus is used with the connection to the chassis being made at the phono input jack. The grounds are arranged on the bus in order of signal level in the circuit, *i.e.*, first stage grid, first stage plate, etc. This prevents ground loops which can sometimes be quite difficult to eliminate.

When wiring the circuit it is best to connect the heaters first, using twisted leads and dressing them close to the chassis and away from low-level points. The small components, such as resistors, are wired next followed by the larger coupling capacitors. This will yield the neatest possible job.

Leads from the primary of the output transformer should not be cut until after the amplifier is tested because, due to the feedback, the circuit might oscillate. This oscillation can be caused by improper connection of the output transformer—so keep the leads of workable length until you are sure of the proper connection.

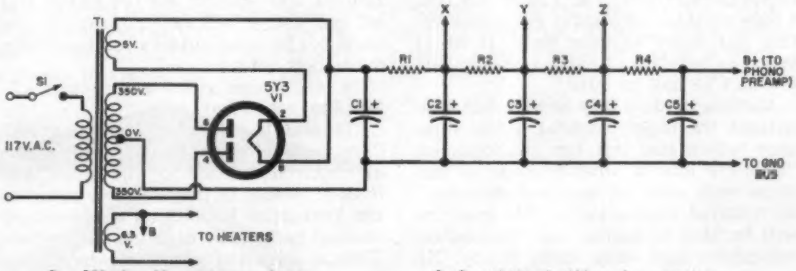
The output transformer used in this amplifier is a small unit with an 8000-ohm center-tapped primary. The capacitor shunting the feedback resistor is selected to prevent oscillation due to phase shift in the feedback loop. The value was chosen to provide a slightly underdamped response to a square-wave input. The exact value will depend on the parameters of the output transformer and should be determined experimentally. The value will be between 100 and 500 $\mu\mu$f.

After the wiring is completed, top and bottom plates of sheet aluminum are installed to provide shielding. The completed amplifier is mounted in a compartment provided for it in the bookshelf enclosure. The back of this compartment is left open to provide ventilation. Since this unit is used on a table, ventilation is adequate. If another arrangement is used, it might be necessary to arrange for additional ventilation in the enclosure or to mount the amplifier separately.

Performance

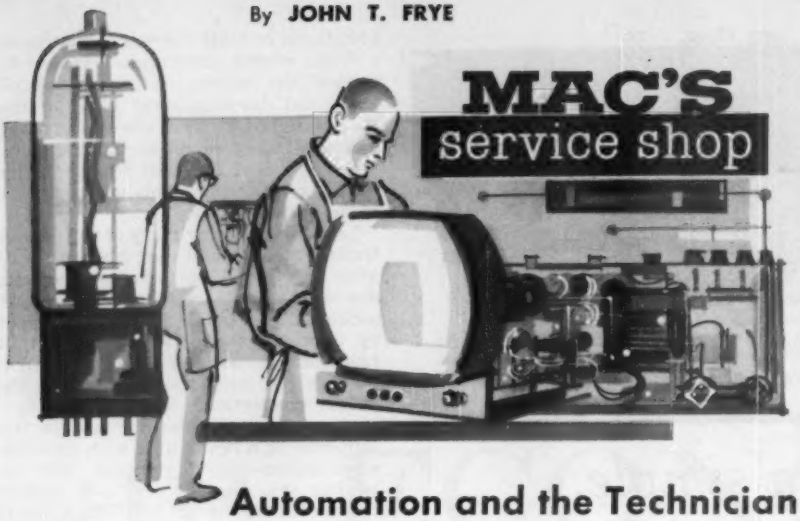
The frequency response of the amplifier, measured from the high-level inputs, is ± 1.5 db from 20 to 28,000 cps at an output power level of 1 watt. When the output power is increased to 10 watts, the frequency response is ± 1.5 db from 25 to 20,000 cps. The hum and noise is 72 db below 10 watts from the high-level inputs and about 65 db below 10 watts from the phono input. The amplifier sensitivity is 0.18 volt at the high-level inputs for a 1-watt output and 0.56 volt for ten watts output. -30-

Fig. 2. Suitable power supply for the amplifier. Point "B" in the heater circuit is connected to the cathodes of the power-output tubes in order to reduce hum.



R_1—750 ohm, 20 w. wirewound res.
R_2—10,000 ohm, 1 w. res.
R_3—33,000 ohm, ½ w. res.
R_4—10,000 ohm, ½ w. res.
C_1-C_3—20/30/40 μf., 450 v. elec. capacitor
C_4-C_5—40/40 μf., 350 v. elec. capacitor
S_1—S.p.s.t. switch
T_1—Power trans. 350-0-350 v. @ 90 ma.; 6.3 v. @ 3 amps; 5 v. @ 2 amps.
V_1—5Y3 tube

By **JOHN T. FRYE**



Automation and the Technician

IT WAS Matilda's treat. The office girl of Mac's Service Shop had made a daring safari through the blazing July afternoon sun to the corner drugstore and had brought back three chocolate sundaes. Now she, Mac, and Barney were seated in the service department contentedly spooning the luscious, high-calorie confections from their cardboard containers. Only the hum of the whirring air-conditioner broke the silence.

As usual, Barney polished off his sundae first and regretfully dropped the plastic spoon into the empty carton. "Thank you, Matilda; you're a jewel," he announced; "and I can't bear the thought of your being replaced."

"Being replaced!" Matilda exclaimed, looking up in shocked surprise. "Whatever are you talking about?"

"I've been doing some heavy reading and hard thinking," Barney said importantly. "The reading has consisted of reports made to Congress last spring by Representative Elmer J. Holland and Howard Coughlin, president of the Office Employees International Union. According to these reports, it is conservatively estimated five million office and clerical jobs will be eliminated through automation in the next five years. In 1961 alone, computer installations will be made affecting 1.4 million clerical workers and eliminating a minimum of 350,000 existing jobs. *IBM* is quoted as saying it has automated only 7% of the work in U.S. offices and hopes to raise this to 35%. Yes, Matilda, I hate to think of a shiny computer sitting out there at your desk. It won't bring us sundaes; I can't tease it; and it won't be half as cute."

Matilda made a face at him, but Mac noticed the happy look of a few minutes before had left her countenance. "There're lots of other reasons no machine will ever replace our Matilda," he drawled reassuringly. "No machine will be able to handle our 'impossible' customers and keep them happy. No cousin of a computer will try to convince us any job giving us trouble is a dog to end all dogs and, when we finally lick it, make us believe we have more knowledge of electronics than there is. Is a covey of transistors going to check our appearance every time we start on a service call to make sure we look clean, neat, and smart? What machine will fuss over us like a hen with two chickens when we burn ourselves with the solder gun or have the sniffles? Finally, no automatic device will light up the whole front end of this place with a smile that is just as warm and friendly at five in the evening as it was at eight in the morning."

"Aw, Matilda knew I was just teasing," Barney said gruffly. "No automatic machine can ever replace a hep girl like her."

"I'm glad, though, you've been thinking about the effects of automation," Mac said as he noticed the little frown disappearing from Matilda's face; "but, Barney, you wouldn't have needed to look so far from your own work for examples of jobs being eliminated by automatic processes. Automation in wiring, soldering, and component assembly in the radio-TV industry has already eliminated some 50,000 jobs, and that's just the beginning. In the telephone industry, business has increased 25% over the past ten years, but there are 30,000 fewer jobs. In 1960 42% more electric lamps were shipped than in 1950, and the productivity of workers was up 52%; yet there were 1500 fewer jobs in the industry. And it's pretty well agreed that between 125,000 and 160,000 auto workers laid off last winter will never return to the factories because automation has taken over their jobs."

"Really makes you think, doesn't it?" Matilda remarked.

"It should anyway," Mac agreed. "I'm convinced automation will make as much difference in the work and lives of people in the next few years as the Industrial Revolution made during the last half of the Eighteenth Century. Then a man-and-a-machine took over the work of dozens of artisans and craftsmen. Now the machine that elevated the operator to power has become so clever and sophisticated it no longer needs his immediate direction, and it is his turn to get the ax. I imagine the ghosts of the old craftsmen who were victims of the Industrial Revolution are chortling at the poetic justice of this."

"I get the feeling changes brought on by automation will happen much faster than those occurring during the Industrial Revolution," Barney said.

"I agree. Some change is always taking place, but the *rate* of change has accelerated steadily during the past few decades. Things are happening faster and faster. As Julius A. Stratton, president of M.I.T., recently remarked, 'The world into which we were born is gone; we have little or no idea of the world into which our children may grow to maturity.' Improved methods of communication, financing, and fabrication permit a new way of doing things to go from drawing board to widespread application in a very short time; and when an idea catches on, such as automation is doing, it can easily change our whole way of making a living in a few short years."

"What I mostly want to know," Barney interrupted, "is how automation will affect the radio-TV service business."

"Only a seventh son of a seventh son could be sure," Mac replied; "but maybe we can make some guesses. Let's continue looking on the dark side first. So far automation has principally been applied to the manufacturing process and so affects us only indirectly. Even so the indirect effect can be terrific. For example, you know how the printed circuit, darling of the automatic machine, has made radical changes in our service procedures. Unitized modular construction in the future could possibly do to us what the sealed compressor unit did to home-refrigerator servicing. This was a booming business when I was a boy. Many fellows made a good living recharging the lines with gas, overhauling compressor motors, and replacing controls. Now, when a refrigerator fails, the whole sealed unit is simply replaced; and there is very little home-refrigerator service work done."

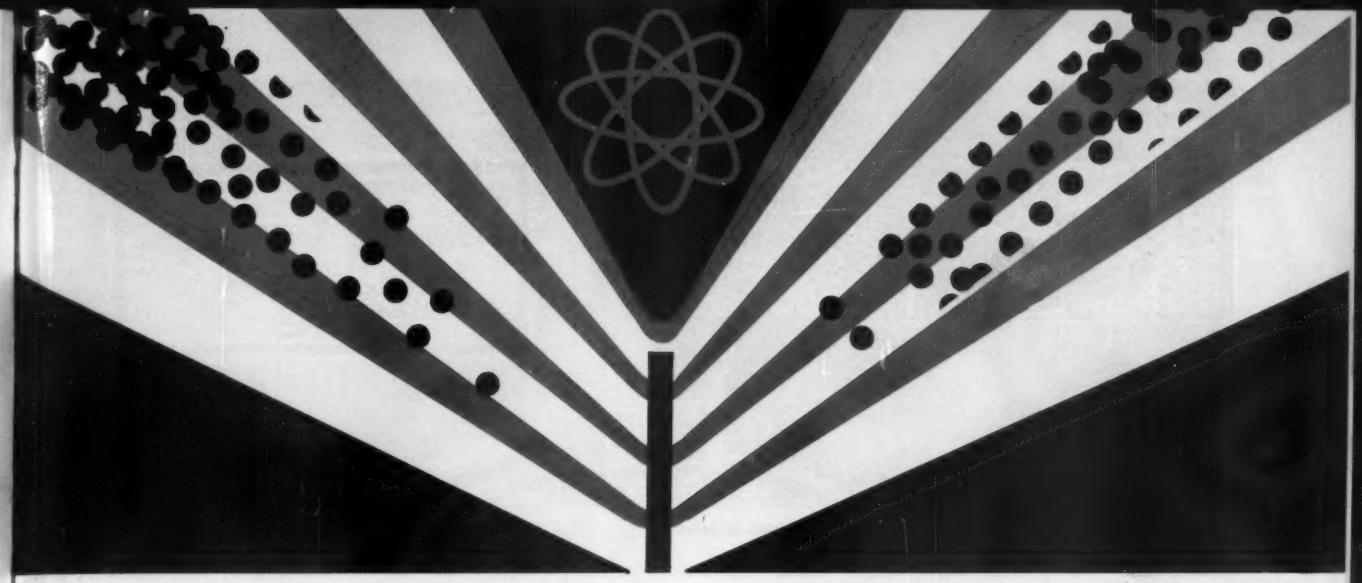
"That's a nice gloomy picture," Barney commented.

"Yes, but there is a ray of light in it," Mac went on with a grin. "Not one of the refrigerator boys who really knew his refrigeration theory and kept up with what was going on in the field lost out. They simply transferred into servicing commercial refrigeration equipment and air-conditioning. Most of them today are making far more money than they did servicing home refrigerators."

"Reminds me of a *refran* I learned in Spanish class," Barney said. "'*Si se te cierra una puerta, otra hallaras abierto.*' Translated that means: 'If one door is closed to you, another will be found open.'"

"Not bad!" Mac applauded. "You must, of course, not waste time kicking on the closed door and be able to see the other door opening."

(*Continued on page* 88)



The Coming Breakthrough in Thermoelectricity

By **DR. JOHN KELLY** / Research Laboratories, Westinghouse Electric Corp.

An important new method of energy conversion which promises increasingly widespread applications for power generation, for heating, and for refrigeration without the use of rotating machinery or moving parts.

ALTHOUGH most of us take it for granted, the conversion of energy from one form to another is essential to anything we do, or expect our machines to do, and is a concern as old as civilization itself. Indeed, the very progress of man is closely related to his ability to uncover, tap, and convert sources of energy into usable power. The quest for raw materials has involved probing beneath the earth's surface, plumbing the depths of its oceans, analyzing the microcosm of the atom, and sending out feelers to the voids of space.

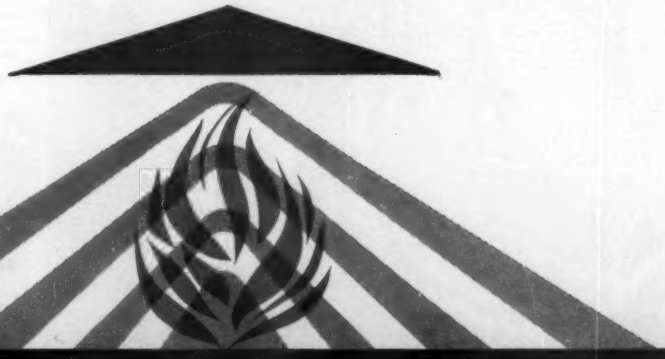
The search for conversion methods, while less spectacular, is not one whit less important, since all the fuel in the world would be useless without a way of using it to do some work. One of the most important forms of energy conversion involves the relation of heat to electricity, or "thermoelectricity."

In one form or another, thermoelectricity is about 150 years old, but research and development in the last five years may well point to a new breakthrough in understanding and application, both in generating electricity and in products—industrial and consumer—in everyday use.

Thermoelectric generators, which produce electrical power by means of heat conversion, have not, of course, replaced conventional generators, nor are they likely to do so in the foreseeable future. Yet their use to supplement or augment existing generators, is more and more indicated both by the need for additional electrical power as well as continuous improvements in thermoelectric materials and the technology needed to use them. Such devices, fired by conventional or nuclear fuels—for land-based or space applications—are constantly emerging from the nation's laboratories. Their efficiency, cost, and other related aspects appear to be favorable enough to indicate that they represent a "coming thing."

A striking thing about thermoelectricity is that it is a two-way affair. Just as heat can be used to produce electrical energy, so can an electric current be used to produce changes in heat and on a scale suitable for anticipated future use in major appliances such as refrigerators. No doubt small appliances designed to take advantage of the compactness, versatility, and convenience of thermoelectricity will precede the larger products, but both types appear to be on the way. Thermoelectricity's greatest impact is expected not so much in replacing existing products, but in helping to create new and different ones. It could, for example, usher in an era of separate, independently controlled, refrigerated storage compartments throughout the home, as contrasted to the single, all-purpose refrigerator of today. The uniform efficiency of a thermoelectric cooler has a decided advantage over the conventional refrigerator in that in the latter type, refrigeration compressors become inefficient and bulky for small size applications.

Other useful items could also result from the new technology. In 1958, for example, *Westinghouse* announced a prototype of a device for heating and cooling a baby's bottle automatically and another device, a mobile hostess cart, has both refrigeration and oven compartments. Last year, two larger, full-scale devices were demonstrated. One was a household refrigerator of ten-cubic-foot capacity; the other, a "hot-cold-light" panel which combined thermoelectric heating and cooling with electroluminescent lighting. With such a panel, a home could be cooled in summer, heated in winter, and lighted the



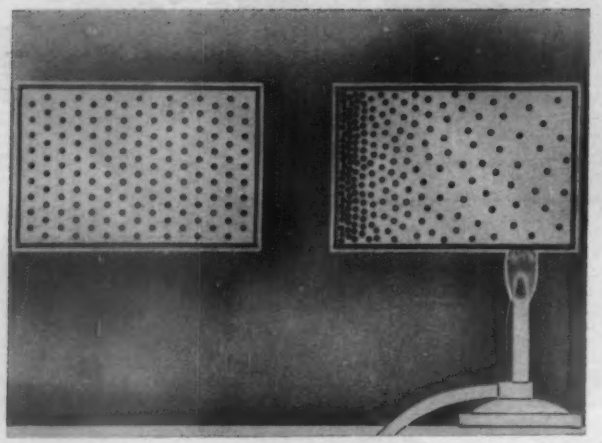


Fig. 1. Distribution of electrons in unheated and heated material.

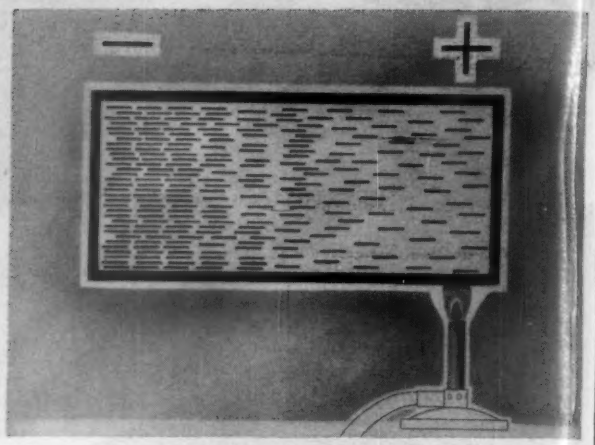


Fig. 2. Difference in charge in the material with one end heated.

year round—all by solid-state devices having no moving parts and under the control of a few dials. Presently being marketed, is a line of thermoelectric components for cooling electronic equipment such as transistors. In addition, small heat pumps for both cooling and heating, based on the thermoelectric principle, are not too far in the future.

Thermoelectricity is actually one aspect of a larger general search for new ways of generating power which involves the use of heat in a changing state, or thermodynamics. It is thus related to three other distinct, although allied, fields. One is a magnetohydrodynamic power, in which electric currents are produced by ionized gas that is blasted at speeds of 1000 to 2000 miles-per-hour through a magnetic field. Generators using this principle and producing up to 10-kw. output have been demonstrated. Another form is thermionic power, based on the electron flow from cathode to anode in a vacuum tube. Special tubes, "thermionic converters," have been used to produce low-voltage power to do modest chores such as lighting an indicator lamp or running a small fan. In addition, combinations of thermionic-thermoelectric devices have been successfully tested to produce small amounts of power. Yet another form is the fuel cell, which generates usable electricity from the combined consumption of gases, such as carbon dioxide and oxygen, inside a high-temperature furnace. One such cell, resembling a large snare drum, heated to about 800 degrees C, has been said to produce 2-kw. per cubic foot.

Of all these new methods, thermoelectric power generation is today the most well-developed and has, in fact, been used to build large and efficient "unconventional" generators.

How It Works

Thermoelectricity, simply, is a property of two different materials joined together and subjected to a temperature difference. A simple explanation of this is given in Figs. 1 through 4. In Fig. 1, the left drawing represents material at uniform temperature; the distribution of electrons is the same throughout. As heat is applied (Fig. 1, right), electrons leave the warmer portion, tending to concentrate in the cooling area. As a result, the material becomes polarized, or charged (Fig. 2) with the cooler section being negative (more electrons).

To use this effect to do work electrically, a closed circuit is needed. As shown in Fig. 3, two dissimilar metals have been joined, and the junction heated. This causes differences in the distribution of electrons in each material. By connecting a wire between the unjoined ends of the materials, the circuit is closed and current will flow. This process is somewhat like the expansion and compression of a gas.

It should be noted that this explanation applies only to a metal-to-metal junction (thermocouple), which has a very low efficiency. Modern methods take advantage of the characteristics of both the *n*-type (electronic) and *p*-type (hole, positively charged) conductors. With these, it is possible to use a thermal gradient to produce, in *n*-type material, a charge gradient as shown in Fig. 2, and in the *p*-type material, a charge gradient of opposite polarity. In other words, the cold end can be charged positively. This is effectively adding potential, rather than creating a difference in potential (as shown in Fig. 3). With such materials and an understanding of semiconductor physics, it is possible to produce efficient thermoelectric generators.

The thermoelectric effect, of course, can be reversed. If heat can be used to pump electrons, then electrons can be used to pump heat. As an electron moves through a material, it carries not only its negative charge, but its associated heat as well. In Fig. 4, a battery is used to send current through a thermocouple circuit. Again, the electrons build up at the junction and tend to expand across it. This expansion requires additional energy, which is extracted from the heat energy in the region of the junction. Consequently, the junction cools. If the direction of the current is reversed, the effect is reversed and the junction will heat.

Thermoelectricity dates back to the "Seebeck Effect," discovered in Germany in 1821, when Thomas Seebeck observed current flow across a thermocouple. In 1834, the French physicist Jean Peltier gave a partial explanation of the phenomenon and observed the

Fig. 3. When two dissimilar materials are joined together and this junction is heated, the electrons are distributed as shown. When the free ends of the two materials are connected together through an external circuit, current will flow in that circuit. This is the principle of the thermocouple, which converts heat energy into electrical energy.

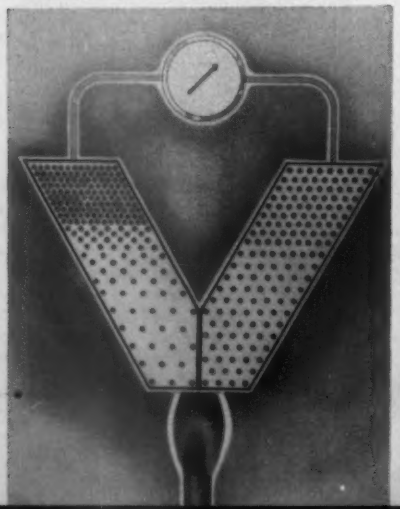
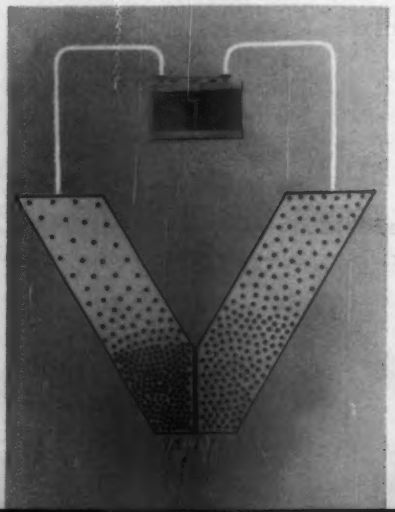


Fig. 4. Demonstration of the reversible characteristics of thermoelectric materials is shown here. The application of the proper polarity of electric current (from a battery in this case) produces the movement of electrons shown. As a result of this, the junction region of the two dissimilar materials is cooled.



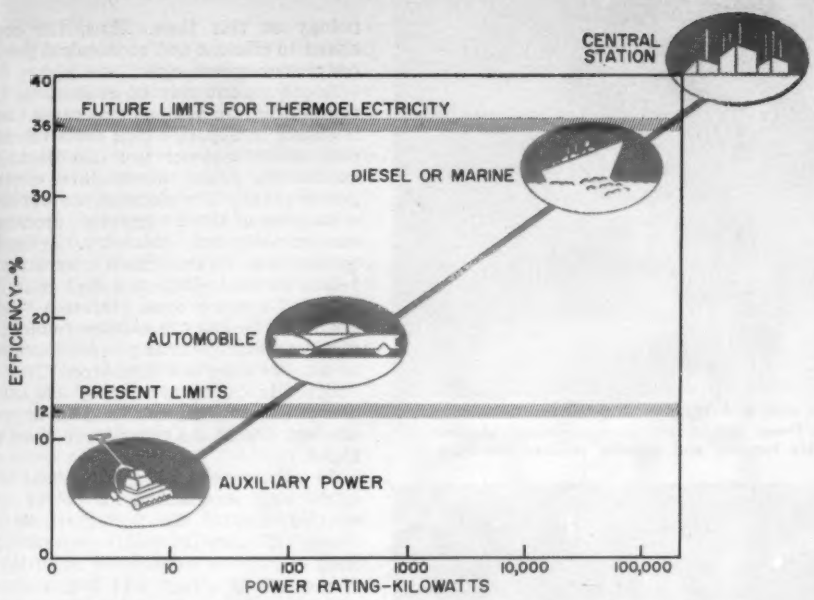


Fig. 5. Efficiency vs power for conventional machines compared to thermoelectricity.

opposite effect: heat energy is absorbed at one junction and is liberated at the other (cooling and warming, respectively) when an electric current flows in such a circuit. This discovery is known as the Peltier Effect. Twenty years later, the English physicist, Lord Kelvin, offered the first detailed theoretical explanation for both the Seebeck and the Peltier Effects.

Practical Uses

One practical use of these phenomena has been in measuring temperatures. The voltage generated by a pair of metals, such as copper and constantan, is measured with a sensitive voltmeter. This voltage, which is a function of the temperature being measured, is typically on the order of a few millivolts for a difference in junction temperature of 100 degrees F.

Serious attempts to use the thermoelectric effect to convert heat to electrical power date back to 1885 and the work of another English physicist, Lord Rayleigh. However, for the next 50 years little progress was made toward realizing practical amounts of power. No known pair of metals permitted efficiencies beyond about one per-cent, too low for most use. Some limited commercial uses were developed; for example, the automatic safety pilot control on home gas furnaces and hot water tanks. But no large-scale applications were in view or even seemed to be theoretically feasible.

New Power Generators

The present-day "renascence" of thermoelectricity has been spurred by the pressing need for electric power in many new applications, such as in remote or undeveloped areas of the earth, as well as an active interest in the space around it. The new developments have been accomplished largely by the work in solid-state physics and semiconductors. With the combination, for example, of *n*-type and *p*-type materials described earlier, it is possible to achieve much higher efficiencies than before. Scientists forecast that the efficiency of thermoelectric generators in the next 15 or 20 years may reach a practical limit of 30 to 36 per-cent. This is still lower than what today's turbine generators can produce, but it nevertheless indicates the extent of development in a very short time and points the way to foreseeable use of thermoelectricity in *some* areas of power generation.

Because thermoelectricity is a simple and competitively efficient way to provide electrical power, one such use could be to serve as a peaking complement to a central power station.

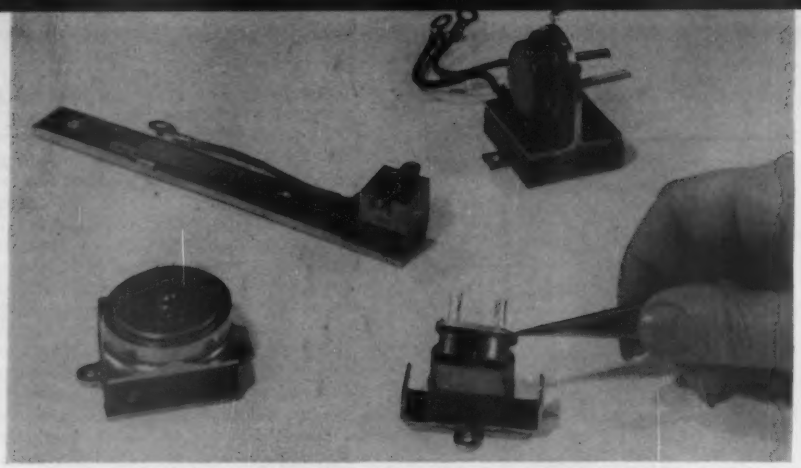
A modern, efficient power plant may have a thermal efficiency of 42 per-cent. This figure is made up of a thermodynamic cycle efficiency of about 45 per-cent and a generator efficiency of better than 95 per-cent. In a thermoelectric generator, much higher temperatures can be tolerated simply because there are no mechanical stresses on the material. This permits cycle efficiencies of 70 per-cent or better. As for generator efficiency, 40 to 45 per-cent is a reasonable forecast. Thus, the thermodynamic cycle efficiency is the most desirable feature of a thermoelectric generator and the electrical generator efficiency is the more desirable feature of a turbogenerator.

(Above) Four typical thermoelectric generators for industrial applications. These units are presently available and are representative of the range of such devices that can be produced. Fuels that supply the heat required for operation include propane or natural gas. Radiating fins on the outside keep the "cold side" of the thermoelectric material at a lower temperature than the heated junctions. The generators shown have outputs of 5, 10, 50, and 100 watts. Voltage outputs range from about 1.7 to 9.4 volts at operating currents of approximately 4 to 13 amperes.

(Below) The 135-degree heat of the test chamber melts a stick of butter, but does not affect comfort of the man holding it. He is wearing experimental air-conditioned suit that keeps him at a temperature of 80 degrees F. A thermoelectric heating and cooling unit is fitted into the back of the suit; the battery pack in the front provides the power to make the suit portable.

The following table shows, for heat rate only, the rather startling differences between thermoelectric and conventional power conversion systems.

	Thermodynamic Cycle	Generator Efficiency	Over-all Thermal
Turbine Generator (today)	45%	95%	42%
Thermoelectric Generator (forecast)	80%	45%	36%



Thermoelectric cooling modules adapted with different mounting fixtures for cooling various sizes and types of transistors. These cooling devices are compact, provide a controlled cooling rate, are extremely rugged, and provide reliable operation.

Small-scale production line for final assembly and testing on several thousand thermoelectric couples which comprise the largest thermoelectric generator ever built. The couples fit into interchangeable trays which line the inside walls of a 5000-watt experimental Navy generator intended for evaluation of materials.

In the laboratory, thermoelectric generators delivering up to 5000 watts have been built. Their efficiencies range from less than one per-cent to about 10 to 12 per-cent. The calculated efficiency, based on materials at hand, is about 18 per-cent. The forecast, as stated earlier, is up to 36 per-cent, based on the ability to solve problems regarding materials. With the growing body of theory in this field, it is now possible to apply the "prescription blank" method of defining the composition of matter. This means it is possible to state a problem, consult the physicist, transfer his prediction of best composition to the chemist, and expect—and get—the desired property in the final material that is produced.

It should be pointed out, of course, that the thermoelectric generator is inherently a low-voltage, high-current, d.c. source. To be used, this d.c. must undergo inversion and transformation to multiphase a.c. To meet these needs, development of compatible static inverters is under way; indeed, inverter technology is ahead of generator technology at this time. Thus, the road ahead to efficient and economical power conversion seems clear.

A convenient way of evaluating the competition for various generator tasks is shown in Fig. 5, which plots efficiencies under average use conditions of auxiliaries, prime movers, and central power plants. The slope of the curve is a function of three variables: economy, convenience, and geometry. Actually, geometry is the only exact criterion and refers to the well-known fact that the ratio of surface area (through which heat may be lost) to volume (which, as displacement, governs power) increases as smaller sizes are considered. This, of course, leads to increasing efficiency. The other two factors tend to depress the left side of the curve more than the right.

In a thermoelectric system, heat leak is the only mechanism for power generation. Hence, the factor which reduces efficiency in small conventional heat engines is inoperative here. What is more, it is a fact that four thermoelectric couples give twice the power output of two. This increased output further substantiates the conclusion that comparable efficiencies can be expected whether the generator is rated at one watt or one megawatt. Thus, all of the area above the conventional power curve, but below the present or limiting thermoelectric curve, can be regarded as noncompetitive. The area common to both means of power generation must be decided on the basis of initial cost only, since there will be little difference in future maintenance costs.

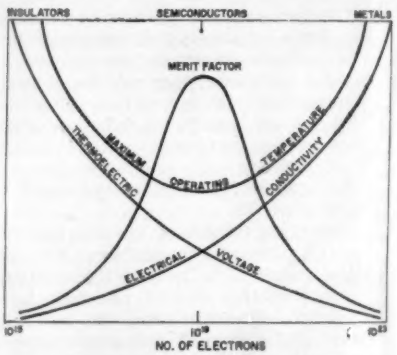


Fig. 6. Physical parameters that determine the best types of thermoelectric materials.

On the basis of capital cost, there seems little doubt that, in the absence of moving parts, thermoelectric generators can be built at a lower cost than their conventional counterparts. This fact would indicate their preference for use in many short-time or intermittent operations, such as peaking or emergency generator conditions.

Suitable Materials

The one major problem in thermoelectricity today is to discover and develop suitable materials. In practice, successful thermoelectric junctions depend on a delicate balance of the properties of the materials used. This balance

(*Continued on page 95*)

COVER STORY

THIS month's cover shows an experimental setup that demonstrates a practical application of thermoelectricity. The photo shows a standard gas furnace including a burner assembly and a squirrel-cage blower and fan (at bottom of assembly). The furnace has been modified so that four thermoelectric-generator modules, each about 8" high x 4" wide x 2½" deep, are mounted around the outside of the furnace combustion chamber. The "cold side" (free ends of the thermoelectric material) is attached to aluminum plates that are exposed to the air. The "hot side" (junction ends) of these modules is composed of a number of thermoelectric pellets whose surfaces are exposed to the air as it is heated in the gas combustion chamber. Therefore, heat is applied to the hot side of the thermoelectric materials and is removed through the cold-side fins. In doing so, the thermoelectric couples generate enough electricity to power the motor that can be seen in the base of the furnace. This motor powers the furnace blower. Hence, this gas furnace needs no conventional electric source to power the blower as other furnaces available today require.

This furnace is an experimental unit being developed by the C. A. Olsen Mfg. Co. and is not available on the market today. It does, however, give an idea of the kind of exciting applications available from the new science of thermoelectricity.

(Cover photo: Westinghouse Electric Corp.)

1 COMPACTRON 3 CIRCUITS

By **SIDNEY C. SILVER**
Service Editor

New Admiral receivers will mark the TV debut of G-E's multi-function component. Here's a circuit preview.

LESS THAN a year ago, the *General Electric Co.* triumphantly heralded a new era in tube technology and, to prove it, exposed several prototype compactrons to public view. Using twelve base pins surmounted by an all-glass shell, it was indicated, a single compactron could house several tube assemblies that would perform the functions of a number of conventional tubes. One sample (see "Compactrons: Advance in Tube Design," ELECTRONICS WORLD, October, 1960) provided up to five tube functions. Others might house a single assembly, but would do so in less space, with greater reliability, and at lower cost than the conventional tubes they would replace.

A multi-function version would occupy little more space than a familiar, miniature tube, employ a single, continuous heater for all sections, cost much less than the aggregate of conventional tubes it threw out of employment, and consume less heater power than separate units. The last factor, in addition to improvements in construction and design, would increase reliability. The cost of compactrons as against that of conventional tubes or transistors, plus the reduction in equipment-fabrication costs now made possible, would enable cheaper, more compact radios, TV sets, and other equipment.

Doubters had one reservation. Initial costs would certainly fall, but what about the price of compactron replacement when failures occur? If one section fails, an entire compactron must be scrapped, and this would have to be more expensive than buying a simpler tube. The manufacturer's answer was the low rate of failure. His life tests showed the new component to be unusually durable.

The final answer would have to be in the hands of equipment manufacturers, whose concern with after-sale reliability and its effects on their reputations had to be reckoned with. And so there was no rush to adopt the new components. However, some equipment makers, *Admiral Corp.* among them, did immediately begin their own testing programs. *Admiral* now reports the "very impressive" results of a series of life tests on the 6K11 compactron, a triple triode. To this day, says the set maker, there has not been a single operational failure. The 6K11 thus has earned its reward: many sets in *Admiral's* forthcoming TV line will use it.

Part of a printed board using this compactron is shown in Fig. 2, with the 6K11 itself highlighted to indicate the small amount of chassis space it preempts. The circuits in which it will function are also worth attention. The three triodes will function as noise inverter, sync output, and a.g.c. amplifier stages. The schematic of Fig. 1 is a simplification of an early *Admiral* version. In final form, there will be some minor changes. However, Fig. 1 suffices for an explanation of operation, as circuit function will be unaltered.

The noise-inverter stage is effectively across the video amplifier. Positive-going plate output from the latter is fed to the CRT through the contrast control, and also to the plate of the inverter through a voltage divider. Input to the inverter's cathode is also the composite video signal but, at this point, taken from the output of the video detector, sync pulses are negative-going.

The effect of the latter input is the same as that of feeding a positive-going signal to the grid; that is, a negative-going output will appear at the plate. This tends to cancel the positive signal applied from the plate of the video amplifier. Without proper biasing, the result would be to kill video. However, we only want to eliminate those high-amplitude noise pulses that may upset the sync circuits. This means the inverter's grid must be biased so that the stage will be cut off except when extraneous pulses larger than the peak value of the video waveform show up.

A fixed bias, taken from the negative d.c. developed at the grid of the receiver's horizontal output tube, is applied to the inverter grid through a noise control. The latter permits field adjustment of the circuit for optimum performance. Another negative d.c. voltage is taken from the a.g.c. line. Since the latter potential varies with signal strength, it will automatically adjust stage bias to the amplitude of the video waveform for the specific transmission being received.

Output from the inverter plate, with noise removed, is then conventionally coupled to the grid of the compactron's second triode, which is a conventional sync separator. With low plate voltage, this stage is biased to conduct only when the high-amplitude sync pulses in the video waveform occur. Its output consists of sync pulses shorn of video information.

The third and final triode of the 6K11 acts as a keyed a.g.c. amplifier. The key-

(*Continued on page* 86)

Fig. 1. Three triodes function as noise inverter, sync separator, and a.g.c. output.

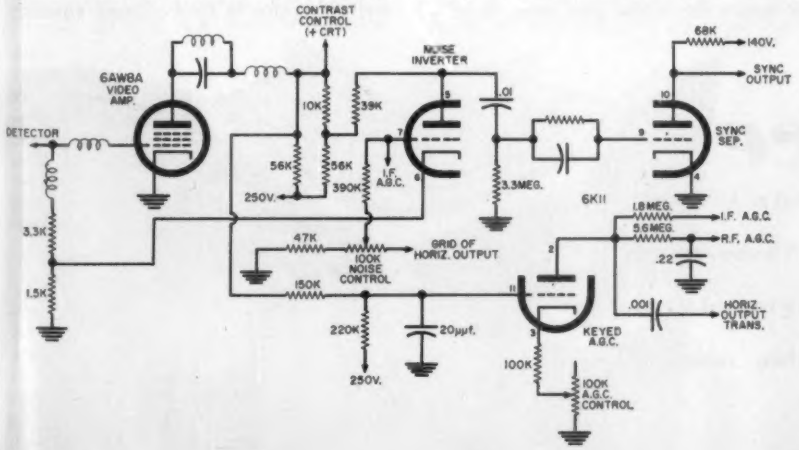
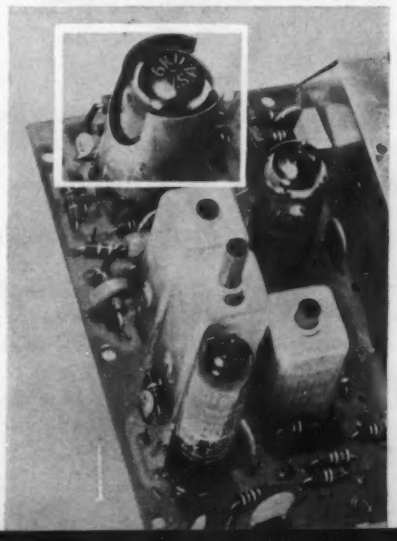


Fig. 2. In space taken by conventional tube, a 6K11 (in box) serves 3 stages.



insurance for service shops

THE BUSINESS end of servicing draws a great deal of attention today, and deservedly so. Inventory control, promotion, record keeping, seasonal planning and determination of profitable service fees are a few of the many subjects constantly broached to the service dealer with the hope that he will help himself become a more efficient, more prosperous businessman. Despite this emphasis, the matter of insurance is seldom brought up. Yet inadequate handling of insurance is as likely as anything else to put a shop owner out of business and possibly reduce him to poverty for years.

Although it can become complex, insurance is too important a subject today to be shrugged off by any businessman. He should be aware of exactly what hazards or perils his business or belongings are insured against. It is also important for him to know what he is not insured for, so he can take proper precautions.

To start with, why do you buy insurance? You buy it so that, *if* something untoward happens, you will be able to carry on without an excessive financial setback and resume your daily living more or less where you left off. The big thing is the *if*. *If* a fire burns the shop down, *if* a wind blows the roof off, *if* a customer is injured on the premises—are you covered?

Fire Insurance

When attention is called to insurance needs, the first kind most people think of is fire insurance. By and large, fire insurance policies are identical in most states, although there are occasional minor differences. Basic coverage provided in a fire-insurance policy is against fire and lightning only, but the policy may be endorsed to cover other things as well. The most common endorsement is called extended coverage. This covers damage caused by wind, civil commotion, smoke, hail, falling aircraft, vehicles (other than your own), explosion, and riot. The policy, with endorsements, may be written on a building or its contents, or both.

While it is not our intent to dissect the policy and delve into its many ramifications, there are a few points that deserve special attention. To start with, the policy is written for a specific period on the described property, at an exact location. The importance of this cannot be overemphasized. It is your responsibility to see that the policy is renewed at expiration if you don't want a lapse of coverage, and to notify the company if you happen to move your business to larger quarters next door or across the street. Otherwise, the company can deny coverage if you place a claim.

Excluded from coverage, according to the policy terms, are such things as accounts, bills, currency, deeds, evidences of debt, money, or securities. So a fireproof safe is the best place for these items—but make sure it's fireproof. Many safes in use today, particularly the older ones, do a miserably poor job of keeping the contents from burning if there is a real fire.

In addition, any fraud or concealment of material facts may void the policy. In other words, it won't help you to try any funny business when it comes to hiding certain hazards from the company to keep your insurance cost down. Then, too, coverage may be suspended if the hazard is increased by any means within your knowledge or control (unless your policy is endorsed otherwise), such as storing explosives or inflammable material not normally incident to the premises, or if the building is vacant and unoccupied for more than 60 days.

Another aspect of fire insurance that few people really understand is the feature of co-insurance. This means that the company and you are both insuring your property together. It is stated in the policy as a percentage. At 80 per-cent co-insurance (the most common percentage), the company is covering 80 per-cent of your property and you are insuring 20 per-cent of it yourself. Why would you want to do this? Mostly because it is much cheaper to buy insurance this way.

The co-insurance clause does not necessarily mean that you must suffer part of every loss yourself. The catch is that the amount of insurance you carry must be at least 80 per-cent of the value of the insured property. As long as you comply with this proviso, the company will pay off any insured loss *in full* up to and including a total loss.

As an example, let's say that you own the building in which your shop is located and that this property is worth $20,000. According to the 80 per-cent co-insurance clause, you must carry at least $16,000 insurance—although you can certainly carry more if you feel conditions warrant it. Suppose a fire occurs that causes considerable damage—say $5000 worth. You will collect the full $5000. But suppose that the fire had gone out of control and the building had burned to the ground. You would still get $16,000, which is the face amount of the policy. It might seem that you would be losing $4000, but this seldom works out in practice. For example, there may be a basement and other parts of the building that will not burn, and there is thus a good chance that the policy will cover all of the actual damage. This is particularly likely to be the case if you have decided to carry more than the minimum amount required by the co-insurance feature because you felt you needed it.

To illustrate the darker side of the co-insurance story, let's assume that, when you bought your shop building some time ago, you paid only $15,000. At that time, you covered it with the required amount of insurance, $12,000, which was 80 per-cent of its value then. In the intervening years, the value of the building has appreciated to $20,000, but you still have the same old policy in force and you haven't increased the face amount.

If the building burns to the ground, you will get $12,000, the full amount of the policy—although probably not enough to cover the full extent of the loss. However, if you suffer a partial loss, you collect damages only within the limits of a formula. The amount of insurance you are actually carrying is divided by the amount you should be carrying. The answer gives you the per-cent of the actual loss that the company will pay for. For example, suppose you have a partial fire loss of $2500. Your policy, which should have been for at least $16,000, is only for $12,000. You will therefore collect only 12/16, or 75 per-cent of your $2500 loss, which is $1875.

Your Responsibilities

In the event of a loss, which can vary from a cigarette burn in the seat of a chair to the complete destruction of a building and its contents, you have several obligations according to the terms of the policy. You must give immediate written notice to the company (usually

handled by the agent); separate damaged from undamaged property; put it in the best possible order; and furnish a complete inventory of the destroyed, damaged, and undamaged property, showing in detail quantities, costs, actual cash value, and amount of loss claimed. Your agent can be a great help in handling the details, but one thing he cannot do (and neither can you) is inventory something that has already gone up in smoke. So by far the safest course is make sure that you have a full inventory in the shop, which is periodically reviewed, and on file in your insurance agent's office. If you don't have time to make a complete inventory, next best is a photographic record. A picture of each wall of every room and the contents of drawers and cabinets has the advantage of being fast, and will serve admirably well in refreshing your memory of what was actually lost, should there be a fire.

One last admonition. If you have several fire policies, perhaps from several agents, make sure they all provide *exactly* the same coverage. This includes endorsements. Otherwise you may find that you are not fully covered for some types of losses. The best way to avoid trouble is to include everything in as few policies as possible, preferably handled by one agent, although this is sometimes difficult for business reasons.

Other Insurance

With adequate fire insurance, you might possibly think that you are pretty well covered for any eventuality. However, if you do have a bad fire, you are still temporarily out of business. You may still have a payroll to meet, other fixed expenses, and no income at all. The answer to this problem is some form of business-interruption insurance which can be written to meet those fixed expenses while you're getting set to re-open.

Another possible need might be insurance against burglary and robbery. There is a wide choice of policies available and you can buy whatever suits your need and pocketbook. However, it might be well to note that, as far as insurance is concerned, there is a wide difference between burglary and robbery.

For a burglary to occur, there must be *forcible entry*. A door must be jimmied, a window smashed, or there must be some other evidence of forcible entry in order for a loss to be covered under a burglary policy. In other words, if a former employee sneaks in some night through the back door with a key he managed to filch, there is no coverage for any loss under a burglary policy.

With robbery, you must be put under threat of physical violence. The guy with a gun in your ribs taking cash from the drawer is robbing you; the fellow that walks out the door with the transistor portable tucked in his pocket is unquestionably a thief—but, according to your policy, he's not robbing you.

Most shops don't, or shouldn't, carry sufficient cash on hand to warrant a large robbery policy and maybe you don't want this type of coverage in the first place. But there is often a large amount of cash tied up in stock and merchandise, so serious consideration should be given a burglary policy. Actually, if you want, you can get a policy to cover both. This sort of storekeepers' burglary and robbery policy covers seven different types of stealing, and also includes damage to property and business money at home.

These policies, along with some of the lesser known forms such as plate glass, profits and commissions, and sprinkler leakage, will adequately protect you from loss of material things connected with your business.

Liability

There is another extremely important type of insurance that covers your responsibility to other people for damage to things that they own or injury to their person. This is known as liability insurance. It covers such things as the customer who trips over the cord of a TV set in your place of business and suffers real or imagined injuries as a result. Many people seem to regard such an occurrence as their great opportunity to get rich quick and some actually make it.

This type of insurance, public liability, covers claims resulting from your negligence, and if you're sued, you are provided with legal defense. Furthermore, any judgements rendered as a result of court action are paid by your company, up to the policy limits. The policy gives you the same kind of protection on you and your place of business that your auto liability gives you on your car, and it's something you dare not be without.

Lesser known legal liability insurance is different and not nearly as essential, from the standpoint of what you could lose without it. Its purpose is to protect property belonging to others which has been left in your care.

If you have any employees you may be required, according to state law, to comply with workmen's compensation and disability laws. However, it's a good idea to carry such protection even if it isn't legally required. Briefly, workmen's compensation provides benefits for your employees if they are injured on the job, and disability benefits relate to injuries or illness not connected with the job.

While not related specifically to your business, serious thought should also be given your personal insurance program, that is, life and accident and health insurance. Here again, there is a wide choice of policies and coverages available that are, in themselves, the subjects of entire books. Discussion of this field falls outside the intended scope of this article and mention is made only because this type of coverage should be included in any broad insurance program that is being developed to meet your needs.

While this has not necessarily been a complete resume of the many coverages available to the small businessman, it does illustrate some of the areas in which the need for protection is greatest. Businesses vary considerably; by far the best thing to do is select an agent in whom you have confidence and have him survey your insurance needs. He will gladly do this free of charge. Then, together, you can decide what your own specific needs are and plan your insurance program accordingly.

Incidentally, don't neglect to do this just because you wish to keep your business "spread around" or feel that you have to. The agent understands this situation as well as anyone and will gladly give his recommendations even though you want to keep some of your policies with other agents to whom you may be obligated.

To summarize, keep in mind an ancient insurance adage, "It's better to have insurance and not need it, than to need it and not have it." -30-

By RICHARD C. SAUNDERS

Against what possibilities do you have to be covered? What amounts do you need for satisfactory protection? How far do your present policies go? Learn the answers.

HUM ELIMINATION IN SCOPES

The greatest obstacle to critical use of less costly instruments usually is unwanted hum—but you can eliminate it. / By ALAN RAUSCHER

ALTHOUGH the oscilloscope is adaptable to a variety of uses, its primary purpose is to provide a visual means for evaluating circuit performance through observation of waveforms. This often involves inspecting the composition of a waveshape in some detail and possibly determining its amplitude.

The scopes used by many service technicians and experimenters are usually priced under a hundred dollars. They are likely to meet the owners' requirements in many important respects but fall short in others. Fortunately, improvements can be made to extend usefulness substantially where exact waveform reproduction is desired. This allows more accurate analysis in such areas, for example, as audio work, although one obviously cannot expect to equal or surpass the performance of professional oscilloscopes that cost many times more.

There are many respects in which the instrument may be deficient. Frequency response may be somewhat limited, sweep range may not be satisfactory, sensitivity may be low, and there may be some non-linearity in the reproduction of symmetrical waveshapes. With the low-priced scopes available today, such defects are not likely to be serious. The buyer may choose among instruments with wide bandwidth and sweep range, high sensitivity, and push-pull amplifiers that are or can be carefully balanced. Unless he owns an old instrument, the user is likely to have satisfied requirements like those noted. However, he may own a relatively new, otherwise acceptable oscilloscope that has quite a bit of hum in the vertical channel. This defect is one of the worst offenders in instruments available at moderate cost.

What Hum Can Do

How serious is the hum problem? Where phenomena of substantial amplitude are being observed, a small amount of hum may not do much to change the waveform. (Even in this case, however, hum may enter beyond the early, low-level stages, as we shall see later.) But the low-amplitude signals frequently observed on sensitive scopes, with considerable amplification used, can be affected seriously.

Fig. 1A shows the trace on the author's scope with no input and vertical gain set no higher than the setting used to observe many common phenomena. The instrument is one of many similar, popular units available in kit form for less than $100 with response to 5 megacycles. None of the hum display may be attributed to stray pickup at the vertical-input terminals, as these were shorted. Fig. 1B gets ahead of the story. It was taken under the same conditions after the modifications described here were made.

Let us examine another before-and-after pairing. Fig. 2A shows a 1000-cycle square wave with horizontal portions of the waveform thickened by hum. Ordinarily it is quite easy to measure the amplitude of a square wave with precision. With hum present, however, it is not easy to determine exactly where the top and bottom portions of the display begin and end. Fortunately, there is no detail to be observed on these flat portions of the trace. In a more complex waveform, however, the blurring could override important details, especially as vertical gain is increased. Also adding confusion is the fact that the effects of hum modulation may vary with different frequencies of the signal being observed. The same 1000-cycle square wave. after modification, is shown in Fig. 2B.

Fig. 3A is a 1000-cycle sine wave that has been distorted by hum. Note how the broadening effect varies along different portions of the trace. This is another source of confusion on many waveforms. This photo was taken after hum had been eliminated from the vertical amplifiers. Entry was through the sides of the unshielded CRT. Apparently shielding of the tube, in addition to improvements in the circuit, is necessary for maximum suppression. After correction, the 1000-cycle sine wave was displayed cleanly, as shown in Fig. 3B.

Frequency of the hum may be 120 cps as well as 60 cps. The broadening of the trace will be most noticeable at sweep rates considerably higher than that of the offending frequency. At even harmonics of the hum frequency, an ocean-wave effect will distort the display.

Sources of Hum

We have already noted that entry of the undesired signal may be through either of two paths. The vertical-deflection amplifiers, which are high-gain circuits, easily pick up hum as a result of poor ground connections, poor lead dress, and leakage from a.c. heaters. This often becomes a greater problem than it need be because the oscilloscope was originally purchased in kit form and constructed without the aid of adequate equipment for insuring the best possible results or without adequate experience in dealing with such circuits.

As to direct pickup by the CRT, which may account for a major portion of the hum present, this is due to the existence of surrounding magnetic fields. Some of these fields may come from other pieces of equipment operating on a.c. that are located near the oscilloscope. However, the instrument's own power supply is likely to be a serious contributor.

Consideration of the possible sources is important not only so that the user may know how and where to proceed in elimination, but also so that he may decide for himself how far he wishes to go. Unfortunately the most thorough eradication of hum can become quite expensive. If substantial reduction rather than virtual elimination will serve the user's needs, it is possible to cut costs.

If the instrument is primarily used for checking per-cent of modulation, for example, extensive changes would not be worthwhile. This would apply to applications where relative amplitudes are important rather than accurate checks of absolute amplitude. For those inter-

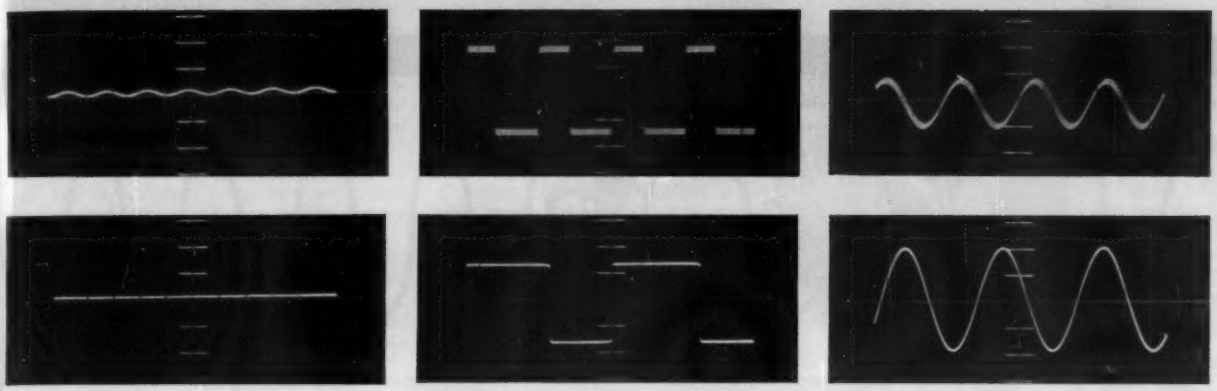


Fig. 1. Hum evident before modification (A, above) with no signal (input shorted) disappears (B, below) after the change.

Fig. 2. Hum-thickened portions of square wave (A, above) falsify amplitude. This is not so after hum is removed (B, below).

Fig. 3. Waveform details blurred or distorted by hum, as in upper sine wave (A), come through clearly in lower trace (B).

ested in checking distortion or phase shift, precise measurement of peak-to-peak readings in TV or audio, or any other type of work where accurate calibration of vertical response is important, hum may seriously reduce the utility of the scope. Extensive modification may then be worth its cost.

Stray Magnetic Pickup

Eliminating the influence of local a.c. fields, if done in the best way possible, may produce enough improvement by itself so that the user feels no need for further effort. However, the best technique possible is expensive. It is virtually impossible to eliminate the fields altogether, so the surest procedure is to protect the CRT from their influence. Complete or nearly complete cancellation can be accomplished by installing a Mumetal shield. However, one such shield may cost $20.

This metallic covering, which encloses the entire length of the CRT, shields ten times more effectively than a similar device made of soft iron. If you decide on this measure, note that the shield must be handled properly. Drilling, filing, or bending can permanently alter the special characteristics of the Mumetal so that its effectiveness is reduced. For this reason, you should order the proper shield for the specific CRT in your instrument from your supplier. If the holes already drilled in the shield do not fit in with the mounting arrangement used for the tube, you are better off fitting the scope to the shield than doing the opposite. It is safer to build mounting brackets into the scope that will enable you to use the existing holes than to drill new ones.

The tube in your scope may already have some shielding, which may be more or less effective. You will doubtless want to know how effective this is before making any investment. The test is simple. Use a gun-type soldering iron or a transformer with the power on. Bring it to within a few inches of the instrument's case. A permanent magnet may also be used. Any deflection or distortion of the trace being displayed indicates the effectiveness or ineffectiveness of existing shielding.

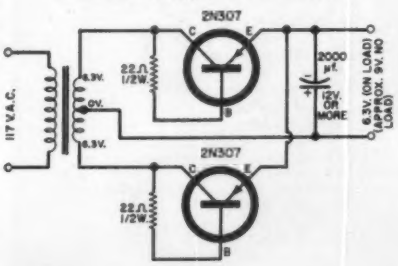
If the cost of Mumetal is prohibitive, fabricating a shield from less expensive material may be useful. Other, less effective, measures for reducing pickup of stray fields involve reducing these fields. These should be tried after the equipment is completely warmed up (at least one-half hour) and with the vertical input shorted to ground. Repositioning the scope, other instruments, and a.c. lines may provide some improvement. Repositioning the scope's own power transformer should also be tried.

Dismount the transformer and twist it in various ways while monitoring the changing effect on vertical hum. The position in which the greatest reduction is achieved (you cannot expect complete elimination) is the one in which the transformer should be remounted. For more precise results, disconnect the leads that go from the vertical amplifier to the vertical-deflection plates of the scope and ground the plates during these checks. If, after doing this, you have reduced but not eliminated hum, there may be some further reduction when the vertical amplifiers are reconnected. Cancellation effects sometimes occur.

Push-Pull Balancing

Those familiar with making balancing adjustments on push-pull audio amplifiers may be familiar with the fact that hum provides a good aural indication. At the point of balance, hum is reduced, although it can be more evident on either side of this point. This also applies to scope amplifiers.

Fig. 4. D.c. on heaters cuts hum. This transistorized supply can be built in.



One important circuit change in the scope to reduce hum, then, is proper balancing of push-pull stages. This is best done according to the manufacturer's instructions. If such information is not available, the user relies on his own knowledge of such procedures. A quick method with conventional push-pull circuits, quite satisfactory, is to measure the plate-to-plate potential between the pair of tubes and to balance until a zero reading on the lowest scale of your v.t.v.m. is obtained. A zero-center scale, of course, will be most convenient for this operation.

A first step could be switching the two tubes and noting what effect, if any, this has on balance. Allow 15 to 30 minutes for warm-up after making the switch. Resistors used in the plate and cathode circuits can be checked for tolerance. In addition to plate voltages, screen-grid voltages should be inspected for deviation. If circuit readings turn up nothing suspicious, a pair of new, matched tubes will probably provide a cure for poor balance.

Note that, like many other measures, this step will seldom result in a drastic reduction of hum. However, one possibility will have been cleaned up and the cumulative effect of several small improvements can be significant in the final result.

Hum from Heaters

If hum introduced through tube filaments is excessive, this simply may be due to the fact that one tube or more has excessive leakage. In this case, tube substitution would produce considerable improvement. However, the most effective method is to use d.c. power on the filaments, or at least on those in sensi-

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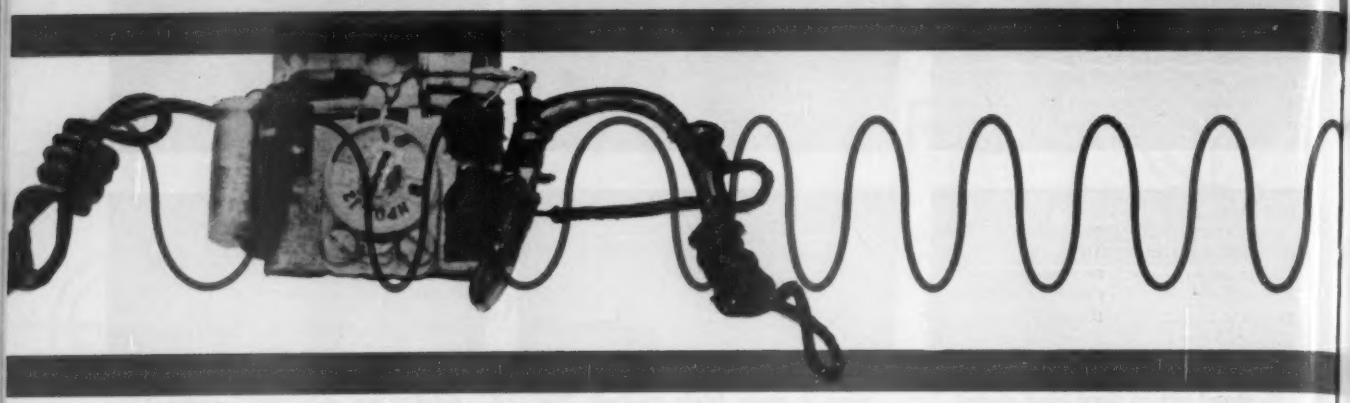


ADD A.F.C. TO TV SETS

By HAROLD B. WILSON, Sr.

A tiny, built-in adapter eliminates the need for fine tuning, improves the quality of picture and sound.

DOES A TV receiver need a.f.c.? On a first impression, the answer is no. Bandwidth of the received signal is broad. A relatively small amount of frequency change due to inaccurate tuning or drift would not seem to matter much. One would expect the effort and expense required for a modification to be out of proportion to the benefits derived.

These conclusions are not absolutely true. Actually the addition of a.f.c. was found to yield gratifying improvement in performance. Adding the required circuitry, which is less critical than one would think, was not difficult, and it was done at a cost of less than five dollars.

On most TV sets, particularly after they age, fine tuning becomes necessary whenever channels are switched. This is not easy to do properly when the user is watching the picture at close range, as when he is making adjustments at the receiver. Rather than make more than one trip to the set, he settles for something less than the best picture and the subsequent effects of drift, as well.

If the user has a set with a remote-control unit, an automatic provision for correct fine tuning is all the more helpful. Sophisticated remote controls permit armchair manipulation of just about every normally used adjustment except fine tuning. If the tuner is off, much of the remote's convenience is negated because the owner must make a trip to the set whenever he changes stations.

In any case, since few viewers have an opportunity to see a set perform while precisely tuned, few know the surprising improvement in performance that results from accuracy. While experimenting with the addition of a.f.c. to conventional TV receivers, the author has switched back and forth between the controlled and uncontrolled conditions. The apparent gain in signal strength with a.f.c. in is quite remarkable, especially on the upper v.h.f. band, channels 7 to 13. Increased sharpness and reduction of noise in the picture were evident, and the enhanced quality of sound was often just as noticeable. Anyone can appreciate the difference, but a viewer who is not receiving particularly strong signals would be most pleased. Although all sets on which experiments were conducted were of the black-and-white variety, the benefits would probably be even more obvious in color TV, where correct frequency of signal components is critical.

Why relatively small errors due to mistuning and drift should make such a difference on a wide-band signal is a matter for speculation. The bandpass of the r.f. amplifier is probably a factor. Although such stages are often considered to have broad response, this is less true of modern tuners than was the case in the past. Today high sensitivity is at a premium. This means operating the r.f. section for higher gain, which, in turn, means narrowing the bandwidth. Thus improper tuning can result in cutting off information at one end of the band to be received.

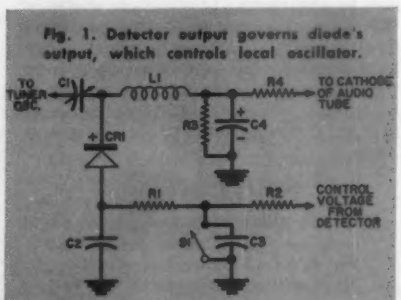


Fig. 1. Detector output governs diode's output, which controls local oscillator.

R_1—470,000 ohm, ½ w. res.
R_2—2.2 megohm, ½ w. res.
R_3—33,000 ohm, ½ w. res.
R_4—100,000 ohm, ½ w. res.
C_1—3-12 μμf. trimmer (Erie "Ceramicon" TS-B or equiv. See text)
C_2—.001 μf., 50 v. disc ceramic capacitor
C_3—.01 μf., 50 v. disc ceramic capacitor
C_4—20 μf., 50 v. elec. capacitor
L_1—1 μhy. r.f. choke
CR_1—Silicon diode (International Rectifier IN599 or equiv.)
S_1—S.p.s.t. switch
2—4-40 x 5/16" screws
2—4-40 hex nuts

The Control Circuit

The circuit used was suggested by an article entitled "Add A.F.C. with a Silicon Diode," in the July 1959 issue of this publication. Its author, Stewart K. Gibson, dealt with improving FM tuners plagued with drift. The simple method involved a few components that would require little space. This seemed ideal for a TV set. It was.

The adapted circuit (Fig. 1) is based on an interesting property of silicon junction diodes. Most of these have quite a bit of shunt capacitance. Furthermore, this capacitance varies with the voltage impressed across the diodes. While this characteristic is a nuisance to design engineers in many applications, it is a boon for us. Consider the classical circuit used to control frequency automatically, the reactance tube. A d.c. voltage, whose value depends on the tuning condition, produces corresponding changes in the effective reactance of the tube. The varying reactance is applied to the receiver's local oscillator to re-tune it correctly.

If a diode has capacitance that may be varied by a voltage applied to it, this simple component can take the place of the more elaborate reactance-tube circuit. That is what happens with the 1N599 in Fig. 1. (Other diodes will also work. This will be discussed later.) A d.c. voltage that is determined by the tuning condition is obtained from the same point in the TV receiver that is used in FM tuners: the output of the sound detector.

In addition to the recovered audio signal (a.f.), a d.c. voltage occurs at this point. When tuning is correct, signal is balanced on either side of the push-pull dectector (ratio detector or Foster-See-

ley discriminator). There will thus be zero d.c. signal at a mid-point in the detector circuit. With off-frequency tuning, signal is not balanced and the d.c. on one side does not balance out the d.c. on the other side exactly. The result is a d.c. voltage whose polarity depends on the direction of frequency error and whose amplitude depends on the degree of error.

The most convenient point for taking off the control voltage from the detector is the top of the volume control in the TV set, if there is no capacitor at this point to block d.c. output of the discriminator. Where the capacitor exists, output may be taken off on the discriminator side of this component.

This voltage will produce the desired range of capacitance variation in the silicon diode. However the entire range may be too high or too low to be used with the tuner oscillator. Thus we also need a fixed d.c. voltage to bias the diode so that it will vary over the correct range of capacitance values. A low, stable, positive d.c. voltage can be obtained from more than one point in the TV set. A simple voltage divider and a capacitor to bypass any signal that may exist at the take-off point will do the trick. The cathode of the audio-output tube is shown as this source in Fig. 1. Other sources and values for the divider-filter network will be discussed later. The value of this d.c. potential should be about 1.6 volts positive in most cases, but this is not highly critical.

In addition to the two connections noted, one more is made to the receiver —the control output to the tuner oscillator. This is connected in place of the fine-tuning capacitor, which is disabled. If a construction method other than that used by the author is chosen, a fourth lead may be necessary to connect the ground for the a.f.c. circuit with ground in the TV set. The author built his addition on a metal plate little more than two inches square. Connected directly to the tuner chassis, this provided common grounding.

Switch S_1 in Fig. 1, which is optional, is not shown in other illustrations. When closed, it provides a.f.c. defeat by grounding out the control input from the discriminator. While the author liked this feature for demonstration purposes, it is not essential. (It will probably push total cost above $5.00!)

The circuit was tried out on a number of TV sets of different design and with various tuners. It worked on all with little difficulty. Specific details, including physical considerations, are given for a particular type of front end that is in widespread use. Where this type is found, little will be left to the reader's imagination. For other tuners, this information will still go a long way toward clarifying practical matters. The type of unit is the popular *Standard Coil* turret tuner in the TV-2000 series, using a cascode r.f. amplifier. The one specifically shown is the TV-2222.

Construction Details

For the reader's convenience, we will number construction steps. He may then check off each as it is completed. The first operation involves the TV tuner itself. In this type, one of the plates for the variable, fine-tuning capacitor is the button *Z* in Fig. 2. This is visible because the rest of the tuning capacitor has been removed, which we are about to do. This other plate is a rectangular metal section normally held in place by the mounting screw in Fig. 2 so that the former is spaced away from button *Z*. Tuning results when the dielectric between the plates, which is mounted on the fine-tuning shaft, is rotated. Here we go:

1. Remove the single screw that locks the outer capacitor plate in position. Discard the plate. This frees the outer, fine-tuning assembly on the selector shaft including the rotatable plate. Slide this shaft assembly off and forget it. You will have no further need for fine tuning. However, save the mounting screw.

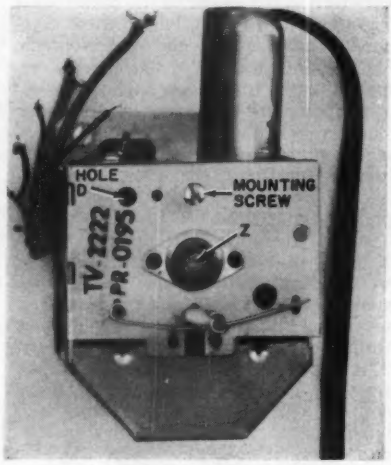


Fig. 2. Turret tuner with fine-tuning metal plate and rotating cam removed.

2. Now make up a plate from a small piece of flat metal similar to the removed plate. For exact dimensions, Fig. 3A, reproduced in the correct size, can be used as a template.

3. Dimensions for the holes and cutouts are given in Fig. 3B. It is best to drill the two ⅛-inch holes (*A* & *B*) first, then the large ½-inch hole in the center, followed by hole *C*. The ¼-inch wide cuts above and below the center hole can be made with a hacksaw. File smooth all rough edges along the lines indicated by *X* marks in Fig. 3A.

4. Using a punch or other suitable tool, emboss stud *D*. This locating stud should project so that it will engage in hole *D* of Fig. 2 when you later mount the circuit plate in position. If the plate is then bent along the lines shown in Fig. 3A so that it will look like Fig. 3B, everything should fall in place later.

5. Now prepare capacitor C_1, the 3-12 $\mu\mu$f. trimmer described in the parts list, so that it looks like Fig. 3C. In original form, its two connecting tabs project outward from the body. Terminal *Y* is cut so that it extends out only 1/16 inch. Terminal *X* is shaped into a wide "U." Now pre-set the trimmer to its minimum-capacitance position (exactly 3 $\mu\mu$f., if you have the right equipment).

6. Mount C_1 on the metal plate, using the two screws and two nuts in the parts list, through holes *A* and *B*. For position, refer to Fig. 4. Tighten the screws, but not enough to crack the ceramic body of C_1. A drop of cement on each nut will insure good lock.

7. Take L_1, the 1-μhy, r.f. choke, and cut the leads so that each is ⅛ inch long. Solder one end to the upper terminal of C_1, as shown in Fig. 4. This is also terminal *Y* of Fig. 3.

8. Take R_2, 33,000 ohms, and solder one end to the free end of L_1. Keep this lead as short as possible. Solder the other end of R_2 to the spot on the metal

Fig. 3. Details (A, B) for subchassis plate; shaping of tabs (C) on capacitor C_1.

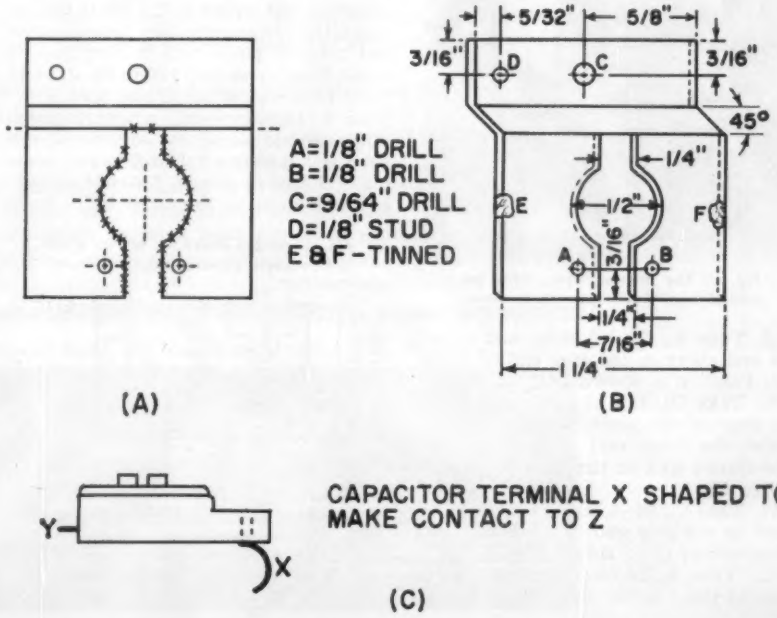


plate identified as *E* in Fig. 3B. This spot should be tinned first, as should point *F*, on the other side of the plate. For position, refer to Fig. 4, as you should be doing for the following steps.

9. Take R_4, 100,000 ohms, and solder one end (short) to the junction of L_1 and R_2. Solder a length (approximately 12 inches) of red hook-up wire to the other end of R_4. Dress this resistor close to R_3, as shown.

10. Take C_4, 20 μf., and solder + end (short) to the junction of L_1, R_2, and R_4. Solder the other end to tinned spot *E*.

11. Take the 1N599 diode, CR_1, and solder the cathode end, as close as possible, to the junction of C_1 and L_1. Position as shown.

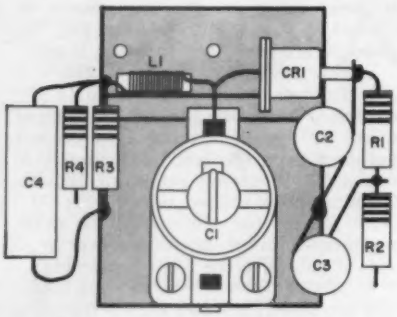


Fig. 4. How components are laid out and wired to fit on compact sub-chassis.

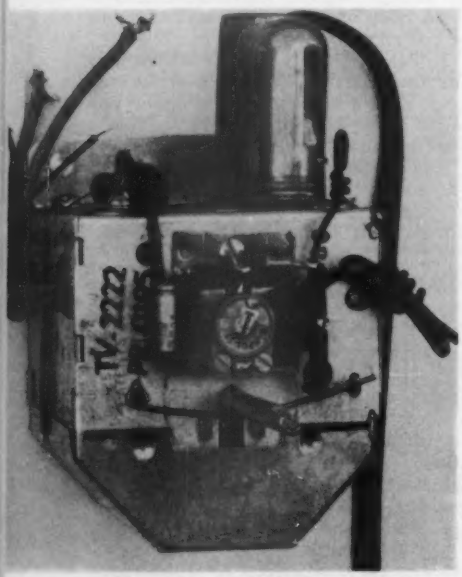


Fig. 5. The altered tuner, with the added a.f.c. circuit mounted in place.

12. Take R_1, 470,000 ohms, and solder one end short to the free end of diode CR_1. Position as shown.

13. Take C_2, .001 μf., and solder one end short to the junction of CR_1 and R_1. Solder the other end of C_2 to ground (the tinned spot on the plate marked *F* in Fig. 3B).

14. Take C_3, .01 μf., and solder one end short to the free end of R_1. Solder the other end of C_3 to tinned spot *F*.

15. Take R_2, 2.2 megohms, and solder one end short to the junction of R_1 and C_2. To the other end of R_2, solder a 12-inch length of green hook-up wire. With this lead, as with the other two wires used, the recommended length is arbitrary. How much wire will actually be needed is determined by the location of the appropriate connecting points in the TV set. It is most convenient to make these leads longer than necessary at the beginning and cut them to fit later on.

16. Take a length of black hook-up wire and solder one end to the junction of R_1, R_2, and C_2. This lead may be omitted if defeat switch S_1 will not be used. The unit is now complete. (To support the three leads, the author added an extra touch. A small loop of stiff wire was twisted around the red lead, and the loop was soldered to point *E*. Another loop was twisted around the insulated green and black leads. This loop was soldered to point *F*.) Check the finished sub-chassis against Fig. 4. C_4, on one side, and R_1 and R_2, on the other side, may be dressed closer to the metal plate than shown in Fig. 4, where these components have been spread out for clarity.

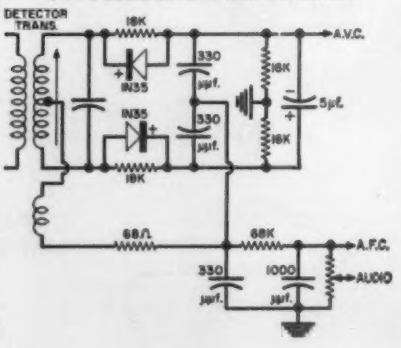
17. Using the mounting screw removed from the tuner earlier, mount the entire plate to the front of the tuner. The screw passes first through hole *C* of the plate and then into the original hole on the tuner. Make sure that stud *D* on the plate properly engages corresponding hole *D* on the tuner.

Also make sure that curved terminal *X* on C_1 makes good electrical contact with plate *Z* on the tuner. The latter is shown in Fig. 2. If you remember, *Z* served as one plate of the original fine-tuning capacitor. Inside the front end, it is connected to the oscillator inductance by a short length of heavy, tinned, copper wire. Our a.f.c. sub-chassis, which takes the place of the variable capacitor, is now physically and electrically connected in place of the removed capacitor. See Fig. 5.

18. The red lead is now connected to a source for the bias voltage (about 1.6 volts positive d.c. is needed). One or two resistors, not shown in the parts list because the values may vary depending on the take-off point, will be required. A small filter capacitor (20 to 50 μf. at 15 to 25 volts should do) is also used.

In a receiver with a conventional audio-output stage, the cathode of this tube is a possible take-off point, especially if it is bypassed. Cathode voltage is likely to be in the order of 12 to 15 volts. In this arrangement, solder one end of a resistor (about 100,000 ohms, 1 watt) to the cathode. Solder the other end of the resistor to the red lead from the a.f.c. unit. This resistor, along with R_3 and R_4 on our sub-chassis, acts as a voltage divider to supply the proper bias voltage. The red lead should be dressed close to the TV chassis.

Fig. 6. Model circuit to act as guide if TV's audio detector must be altered.



If the audio-output cathode is not to be used, any filtered source of about 100 volts positive will do. The screen supply for i.f. tubes is a possibility. In this case, a resistor of about 3.7 megohms is connected between the 100-volt point and the red lead. To their junction, one end of another resistor (about 560,000 ohms) is connected. The remaining end of the second resistor is soldered to ground. As in the preceding paragraph, the red lead, cut only to the minimum length needed, is dressed close to the TV chassis.

19. Take the additional capacitor mentioned earlier (step 18) and solder one end to the junction of the red lead with the resistor (or resistors). The other end of the capacitor is soldered to TV ground. If the two-resistor network is used, the capacitor will thus be across the second resistor. This filter (which may not be necessary) will bypass any a.c. that may still be riding in from the voltage take-off point in the receiver. If some signal should get through to the a.f.c. unit, the latter will still work in that frequency control will be automatically exercised. However, there may be some degradation of picture or sound.

20. Dress the green wire, close to ground, to the audio take-off point in the sound detector, using the shortest path. Solder the lead to the take-off point. Some mention has been made of this spot earlier. More will be said later.

21. (Optional) Install defeat switch S_1 at the front of the TV chassis close to the tuner. Solder one switch terminal to ground. Solder the other terminal to the black lead (cut as short as possible) from the a.f.c. unit. This completes the installation procedure.

Adjustments and Checks

The TV set can now be turned on. Let it warm up for a while and, if the defeat switch is used, make sure that it is in the "a.f.c. on" position, or open. The oscillator slugs in the tuner will have to be re-adjusted, so start with channel 2 and adjust for best sound and picture. There will be little difficulty in finding the right point because, as you get close to it, the a.f.c. circuit will "grab" or lock it in. To make sure you are properly centered, you can key the defeat switch on and off during this procedure. If you haven't bothered with the switch, use a shorting jumper across C_3. Go through the procedure described for each channel.

Unless you have been getting exceptionally good reception before this addition, you should notice a definite improvement, aside from the convenience of the circuit. If you are not getting the desired results, which should be obvi-

(*Continued on page* 94)

STEREOPHONIC

FM Multiplex System

By **DANIEL R. von RECKLINGHAUSEN**/Chief Research Engineer, H. H. Scott, Inc.

Authoritative details on the newly approved method of broadcasting stereo programs over a single FM channel.

ON APRIL 19th, the Federal Communications Commission issued specifications for the standard of modulation of FM multiplex broadcasts. This decision came after long, careful deliberation and study of many possible multiplex systems. At least 17 different systems were proposed, some of them dating back a good many years. The National Stereophonic Radio Committee, with the help of engineers, members of the Electronic Industries Association, representatives of the Institute of High Fidelity Manufacturers, Inc., as well as other agencies including the FCC, studied all of these systems and narrowed the field to eight systems of six basically different groups.

In May 1960, the FCC issued Docket 13506 calling for technical comments and field tests of these systems from the same station. Six of these systems underwent field tests in July 1960, using the facilities of KDKA in Pittsburgh— with receiving facilities at the Uniontown Motel in Uniontown, Pa. Many hours of test recordings were made on tape, along with the measurement of many pertinent parameters. This data, plus an analysis of all aspects of the systems tested, was then submitted to the Federal Communications Commission in the form of a report—as bulky as two New York City telephone directories.

System Specifications

The system adopted by the Federal Communications Commission is along the lines of the methods proposed by *General Electric Company* and *Zenith Radio Corporation*, with certain aspects of the system developed by the FCC. These are the essential specifications of the FM stereo broadcast transmission:

1. The modulating signal for the main channel is the sum of the left and right audio signals.

2. A pilot carrier at 19,000 cycles, ± 2 cycles, modulates the main carrier between 8 and 10%.

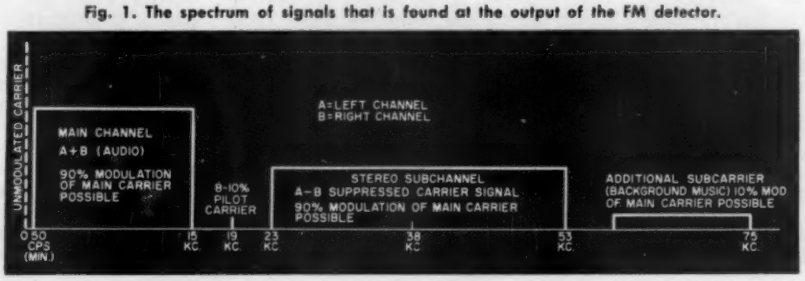
3. The subcarrier is the second harmonic of the pilot carrier and crosses the time axis with a positive slope simultaneous to each crossing of the time axis by the pilot carrier.

4. The subcarrier is amplitude-modulated and the subcarrier itself, but not its sidebands, is suppressed to less than 1% modulation.

5. The modulating signal for the subcarrier is the difference of the left and right signals with a frequency response of at least 50 to 15,000 cycles with 75-microsecond pre-emphasis. The main channel modulation, as in present monophonic service, has the same requirement of frequency response and pre-emphasis.

6. The sum of the sidebands resulting from amplitude modulation of the subcarrier causes a peak deviation of the main carrier of 45% when only the left or right signals are present. The individual maximum modulation capabilities of the main

Fig. 1. The spectrum of signals that is found at the output of the FM detector.



carrier and the subcarrier are 90% since the former reaches a maximum when the latter is zero, and *vice versa*.

7. The frequency response of the subchannel is identical to the main channel (including pre-emphasis) to within 0.3 db over the whole frequency range and the phase response must match to ± 3 degrees. This results in a minimum separation of 29.7 db, maintained from 50 to 15,000 cps.

8. The distortion requirements of the subchannel are the same as for the main channel and also for monophonic service. The distortion of the audio equipment in the studio, the transmitter, and its monitor operating together with proper pre-emphasis and de-emphasis networks cannot be higher than 3.5% between 50 and 100 cycles, 2.5% between 100 and 7500 cycles, and 3% between 7500 and 15,000 cycles.

9. Background music operation (SCA) is permitted. However, the background music carrier may not modulate the transmitter more than 10% and the crosstalk from the background music channel into either stereo channel must be at least 60 db down from 100% modulation.

Spectrum & Waveforms

Fig. 1 shows the spectrum which can be found at the output of the FM detector. In normal monophonic operation of the station, only the main channel and perhaps the additional subchannel for background music is used. For stereo operation, the maximum modulation of the main channel is then reduced from 100% to 90%, causing a volume change of less than 1 db which is inaudible for all practical purposes. In addition to that, the pilot carrier and the subchannel with stereo information is activated. It should be noted that the main carrier of the station is modulated with FM and never with AM. Therefore, all advantages of FM are maintained.

The FCC system of stereophonic broadcasting had its inception in a time-division multiplex switching system. Here, the input of a transmitter is switched rapidly between the left and the right stereophonic program channels, switching at a 38-kc. rate. The system was analyzed mathematically and with test equipment. It was discovered that this system was basically a "sum and difference" system. The sum of the left and right stereophonic channels appeared as audio modulation of the main carrier, whereas the difference between the left and right stereophonic channels appeared as suppressed-carrier amplitude modulation of a series of odd harmonics of the switching rate. Since FCC regulations do not permit the radiation of any signals in excess of 75,000 cycles, filtering of the higher harmonics of the switching rate resulted in the adopted system.

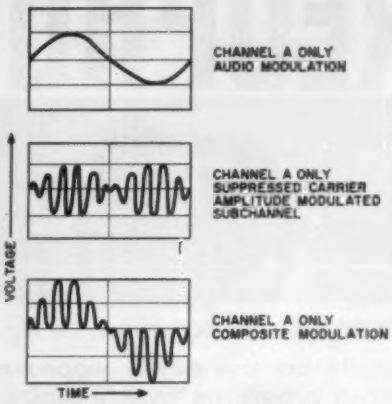


Fig. 2. Waveforms at the output of the FM detector with a sine-wave modulation on the left channel. Pilot carrier has been omitted.

Fig. 2 shows the waveforms which can be found on the output of the FM detector of a high-quality FM tuner. In this illustration the presence of the pilot carrier has been omitted for the sake of clarity. For example, only the left channel (channel A) is modulated with a sine wave. The sine wave itself will be found if the output of the detector is examined with an oscilloscope and a low-pass filter. The use of a high-pass filter will then show the suppressed-carrier amplitude-modulated subchannel. The elimination of all filters will then show the composite modulation which is the sum of the audio modulation and the subchannel modulation. Here it can be seen that channel A is turned on several times during the complete audio cycle and turned off just as many times. The right channel (channel B) is not modulated.

The left and right channels can carry completely separate and uncorrelated information, which is often true in sterephonic recordings. In Fig. 3, channel A carries the high-frequency audio modulation, whereas channel B carries a low-frequency audio modulation. The summing of both of these modulations results in the main channel modulation which shows the high-frequency sine wave superimposed on a low-frequency sine wave. The subchannel shows the difference of the two modulating waveforms as the carrier envelope of the suppressed carrier signal. Both the main channel and the subchannel modulations form the composite modulation which now clearly shows the presence of both waveforms. The shaded areas shown in the last two portions of the figure are actually the high-frequency sidebands of the subcarrier.

The new FCC regulations concerning stereo broadcasting became effective June 1st. Because broadcasting equipment is still in short supply and only the major cities are likely to feature multiplex stereo broacasting, the waveforms described probably cannot be observed immediately. However, since stations presently engaged in AM-FM simulcasting are the ones most likely to carry stereo multiplex broadcasts, a phone call to the station should elicit information as to when stereo broadcasting is likely to start.

Receiving Stereo Broadcasts

To receive these stereo broadcasts, a multiplex stereo tuner or an FM tuner with a multiplex adapter will be required. Fig. 4 shows a block diagram of a stereo tuner. The signal from the antenna passes through the r.f. amplifier, mixer, and oscillator and is then amplified further in the i.f. amplifier at an intermediate frequency of 10.7 mc. and detected as in monophonic service. For normal monophonic service, the output of the detector is then passed through a de-emphasis network and amplified still further in an audio amplifier. At the output of the FM detector, the composite stereo signal is available. It is then split into two paths, one path containing the 19-kc. pilot or synchronizing carrier. A filter selects this pilot carrier and this block also contains means to produce a 38-kc. carrier frequency to be fed to the stereo demodulator, which also receives the composite signal. After de-emphasis of the left- and right-input signals, further audio amplification is required to give a left and right audio output of sufficient amplitude.

Fig. 5 is a block diagram of a multiplex stereo adapter, shown in greater detail. Since the stereophonic system that has been described is a "sum and

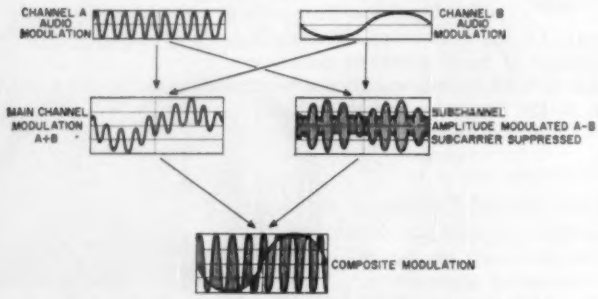

CHANNEL A AUDIO MODULATION
CHANNEL B AUDIO MODULATION
MAIN CHANNEL MODULATION A+B
SUBCHANNEL AMPLITUDE MODULATED A-B SUBCARRIER SUPPRESSED
COMPOSITE MODULATION

Fig. 3. Output waveforms with high-frequency audio modulation on channel A, and low-frequency audio modulation on channel B.

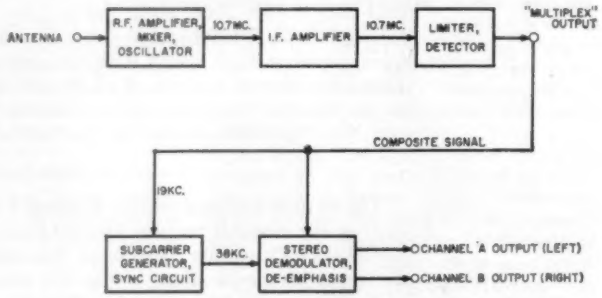


Fig. 4. Simplified block diagram of a stereo FM tuner that will produce signals for application to a stereo amplifier.

difference" system, the stereophonic subcarrier may be demodulated by a synchronous detector to recover the difference modulation and the main channel sum modulation may be matrixed at audio frequencies with the conventional circuitry to derive the left and right signal outputs. Here, the composite output signal of the FM detector must first be amplified to overcome the insertion loss of the matrix network and to operate the AM detector at its proper level. The carrier of the AM detector may be provided by selecting the output of this amplifier with a 19-kc. filter, amplifying this signal, and using the second harmonic (38 kc.) as the inserted carrier to the AM detector. The output of the amplifier will also pass through a 23-53 kc. bandpass filter into the AM detector. In this case, the synchronous detector would be a double diode for recovering

The adapters described here are of a rather simple nature. Such adapters would be used where cost is of prime importance and the various aspects of performance are perhaps of a secondary nature, especially as far as ultimate quality performance is concerned. The quality of the FM tuner employed will also affect the various performance aspects rather severely. For example, if it is desired to maintain a 30-db channel separation, then the frequency response of the tuner with the adapter amplifier may not vary more than 3/10 of 1 db from 50 to 53,000 cps, and the over-all phase response from antenna input to stereo detector input may vary no more than ± 3 degrees from a linear phase line over the same frequency range. This performance aspect is considerably more stringent than that required for monophonic operation.

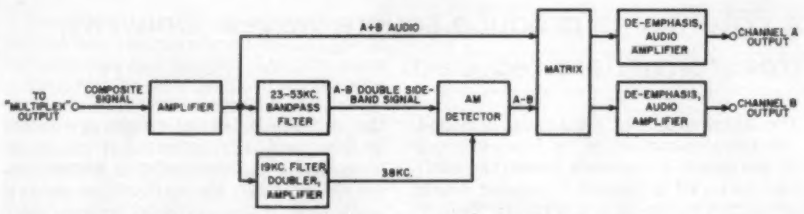


Fig. 5. Block diagram of a multiplex stereo adapter showing the circuits required.

both polarities of the A − B audio signal which is then matrixed with the A + B audio signal from the amplifier. Both the A − B and A + B signals may contain a de-emphasis network. However, better separation results if the de-emphasis network is placed after the matrix network in the circuit. The matrix network would be nothing but a set of resistors. Further audio amplification is required to give proper audio output.

The synchronous detector could be driven by an electron-coupled 19-kc. oscillator with frequency doubling in the plate circuit so that the 38-kc. reference carrier may be correctly re-inserted in the modulated subcarrier signal. The oscillator synchronization would be accomplished by injecting the 19-kc. pilot carrier into the oscillator tank circuit. It is important that the proper phase relationship between the inserted carrier and the A − B double-sideband signal be maintained. A phase error of 12 degrees can result in separation being reduced to 20 db. An 180-degree phase shift would result in an interchange of the left and right audio outputs.

The A and B output signals may also be derived directly in one operation on the composite modulating signal appearing at the composite signal amplifier output. Such a detector would make use of a tube similar to the 6AR8 beam deflection tube. This tube has one control grid, two plates, and two deflecting plates. The reference carrier of 38 kc., derived as above, is applied to the deflecting plates and the composite stereophonic signal is inserted at the control grid. The two plates will have as outputs the product of the reference carrier and the composite signal which is, of course, the left and right signal.

The internal impedance of the multiplex output of the tuner and the input impedance of the adapter can affect frequency response severely and, to a greater extent, the phase response if an adapter of one make is used with a tuner of another make. For this reason, the prospective buyer of a multiplex adapter should check with the manufacturer of his tuner as to the type of multiplex adapter to buy and also as to the extent of the modifications required of the tuner to be able to obtain maximum performance.

As the block diagram of Fig. 4 indicates, full advantages of FM are maintained since the limiter or limiters in the tuner are in normal operation as in standard monophonic service. The amplitude modulation of the subcarrier is strictly a subsidiary modulation and the output voltage of the subchannel detector will be proportional to the subchannel output voltage of the FM detector in the tuner. Since the main channel output voltage at the tuner may vary with signal strength, the subchannel output voltage will vary as well. Because of the proportionality of output voltages, separation of left and right channels will be maintained irrespective of signal strength and, therefore, no front-panel separation adjustment is required. Such a control may actually be harmful since this control is very likely to be misadjusted by uninformed friends, neighbors, or children and the correct setting can be found only when the test signal is transmitted by the station equipped to broadcast multiplex stereo.

A separation control may still be found as a screwdriver adjustment on certain adapters to compensate for tolerances in the matrix network or the subchannel frequency response of the tuner. For the latter deficiency, this control will be quite beneficial in adjusting for good separation at low- and mid-audio frequencies. However, a good high-frequency separation will be obtained only if proper equalizing networks for the tuner's frequency response are used. The characteristics of these networks will vary among different types of tuners. This is one example where the quality of the tuner, along with the quality of the adapter, and the design of both will have an important effect on stereo performance.

Background Music Operation

As the FCC specifications indicate and as illustrated in Fig. 1, background music operation (SCA) of FM radio stations is still permitted. However, these types of signals will have to be broadcast on a fairly high-frequency subcarrier (such as 67 kc.) when the station is engaged in multiplex stereo operation. The careful design of the stereo multiplex adapter will have a great influence on the amount of interference which will be experienced when such a background music channel is in operation. The transmitter's design and adjustment will also affect this type of inter-

First photo received by the editors of a multiplex adapter designed in accordance with the recently announced FCC-approved system. The unit is the H. H. Scott Type 335, a wide-band self-powered adapter, which is being sold for just under $100.

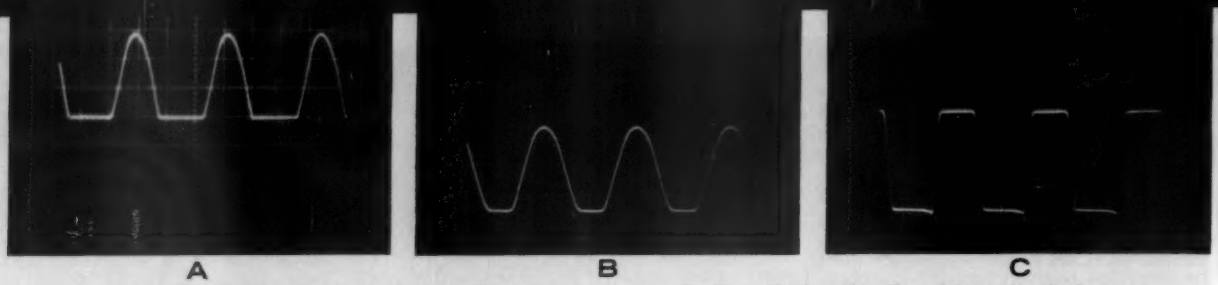
ference. However, the maximum transmitted interference (−60 db) is specified by the FCC.

A station not engaged in stereo multiplex may operate its background music carrier or carriers in the band between 20 and 75 kc. It is therefore possible that this type of background music modulation may be picked up by a multiplex stereo tuner. The type of interference which will then be heard can be described as a "swishing whistle," the swishing controlled by the rate at which the background music is performed. Such a noise would be an indication that that particular station has a background music carrier in operation and is not broadcasting stereo. These types of noises are not the fault of the tuner or the adapter.

Some Problems

The stereo multiplex system adopted

(*Continued on page* 92)



A B C

Waveforms obtained in the circuit of Fig. 1. (A) is the voltage across R_1. (B) to (E) show the effect of increasing the input amplitude at 60 cps. The waveform at (D) is about what would be expected at 6.3 volts input. (F) is the output waveform obtained when an audio oscillator set at approximately 500 cycles per second is substituted for the 6.3-volt heater

Simple Square-Wave Generator

By C. E. MILLER / General Radio Co.

Construction of an ultra-simple clipper that employs contact potential to produce square waves. Only two resistors, a tube, and a transformer are required.

UNTIL the Second World War the use of square waves in testing electronic equipment was limited almost entirely to laboratories and commercial manufacturers. Since that time there has been a growing recognition of the value of tests involving nonsinusoidal waveforms. Most square-wave generators are characterized by complex circuits, waveform distortion, or high cost. A limiter-type sine-wave clipper gives good results with a simple circuit, but

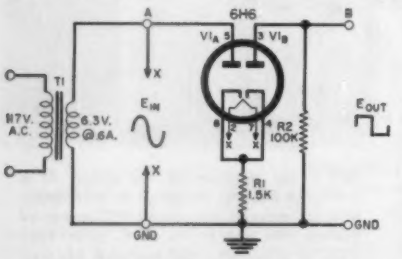


Fig. 1. Schematic of a unit using a twin-diode. If a twin-triode is used, the control grids should be tied to the cathodes.

usually requires an additional power supply, batteries that must be replaced, or expensive zener diodes.

The device to be described is very simple, yet has few of the disadvantages of other types of square-wave generators.

Theory of Operation

The circuit of the square-wave generator is shown in Fig. 1, although its operation is not too obvious from this schematic. A sinusoidal input voltage is applied between point "A" and ground and a square-wave output voltage appears between point "B" and ground. Unlike a conventional sine-wave clipper, this circuit requires no external bias voltage. Instead, the circuit generates its own direct voltage, which is then chopped by the input voltage.

The direct voltage in the circuit is developed by Edison Effect in V_{1B}. When the temperature of a material is raised, the random motion of its free electrons is increased. In vacuum tubes, the cathode material is heated to a point where some free electrons are actually "boiled" from its surface. These electrons form a space charge (or space cloud) about the cathode. With no external voltage applied between the plate and cathode, the space charge forces many of the electrons on the outer boundary toward the plate, giving it a negative charge. The cathode becomes positive because of its loss of electrons.

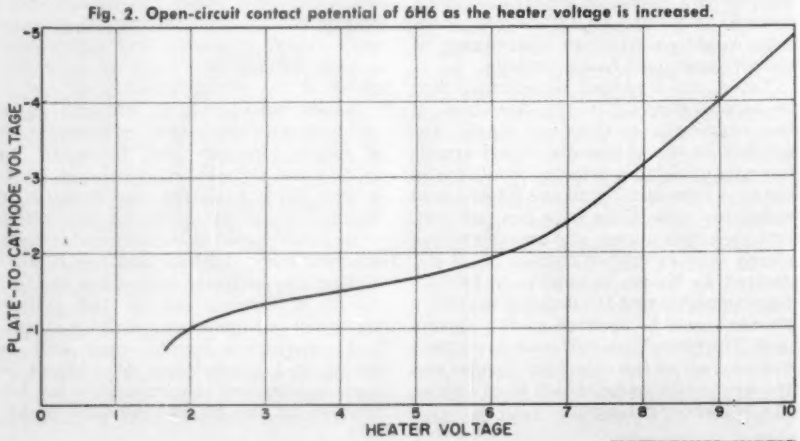
This process continues until the plate becomes sufficiently negative with respect to the cathode to repel space-charge electrons back to the plate-to-cathode region. The magnitude of this plate-to-cathode voltage, sometimes referred to as contact potential, depends principally upon the composition of the cathode material and the temperature to which it is heated. Fig. 2 illustrates the fact that contact potential may become as large as several volts at high cathode temperatures.

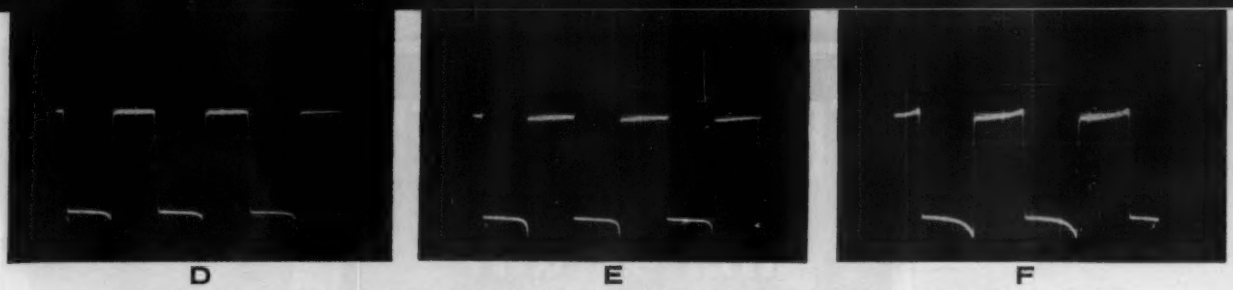
If the external circuit between the cathode and plate of V_{1B} is closed, as it is by R_1 and R_2 in Fig. 1, for example, the contact potential causes a current to flow as if there were a battery in the circuit. Thus, some of the energy required to heat the cathode in normal operation is also utilized to provide a d.c. source in the circuit. If the negative plate-to-cathode potential is increased substantially by means of an external negative voltage applied to the plate, current in V_{1B} will cease to flow.

A sine-wave signal applied at point "A" is rectified by V_{1A} and appears across R_1 with respect to ground. On negative input peaks, no current flows through R_1. On positive input peaks, the full input voltage developed across R_1 causes the cathode of V_{1B} to go positive with respect to ground. Hence, V_{1B} is biased off by positive peaks of the input signal, while during negative peaks the Edison Effect previously described takes place. If R_1 (required only to provide a chopping signal from the input voltage) is made small compared with R_2, almost all of the contact potential appears at "B" with respect to ground when V_{1B} conducts. As the output is taken only across R_2, the output consists of the chopped contact potential exclusively.

If the peak value of the input voltage

Fig. 2. Open-circuit contact potential of 6H6 as the heater voltage is increased.





transformer. An audio oscillator output voltage on the order of 5 to 10 volts is required for proper clipping. Because of the manner in which these traces were photographed off the screen of the oscilloscope used, the waveforms shown here appear as though the oscilloscope sweeps from right to left as would occur in a mirror-image of the actual waveforms.

equals the contact potential, the output voltage resembles the output of a half-wave rectifier circuit without a filter. Increasing the amplitude of the input signal considerably reduces the rise and decay times of the output waveforms. This is clearly illustrated in the oscillograms.

Description of Unit

One advantage of this circuit is that almost any thermionic-emission type of vacuum tube can be used. Also, the same voltage can be used for both heater supply and input voltage. Although a twin-diode was used by the author, multi-elements tubes may be used equally well. When a triode is used, the control grid should be tied to the cathode for best results. The only limitation on tubes is that they must be of the indirectly heated cathode (heater-cathode) construction.

As with any source, output amplitude decreases as the output load increases. In this case, the total load is R_2 plus the device under test, connected between point "B" and ground. The effect of this loading on the output voltage is shown in Fig. 3. If maximum output is desired, R_2 should be from 1 to 10 megohms. The principal load is then only that provided by the input circuit of the device under test. Changes in this impedance will cause relatively large changes in the output amplitude. If it is desired that the output voltage remain essentially constant with changes in load impedance, R_2 may be made relatively small. Then the total parallel resistance presented by R_2 and the changing load impedance will be essentially constant.

The photographs illustrate a unit built around a 6H6 twin-diode. The transformer provides both the heater voltage and the input drive signal, making it a completely independent unit with a 60-cycle square-wave output. For operation at other frequencies, the input signal may be obtained from any sine-wave generator with a 5- to 10-volt output. —30—

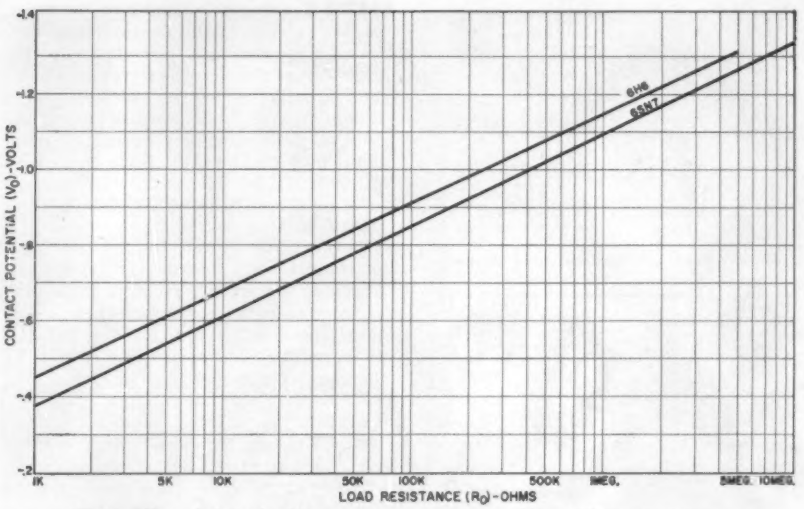
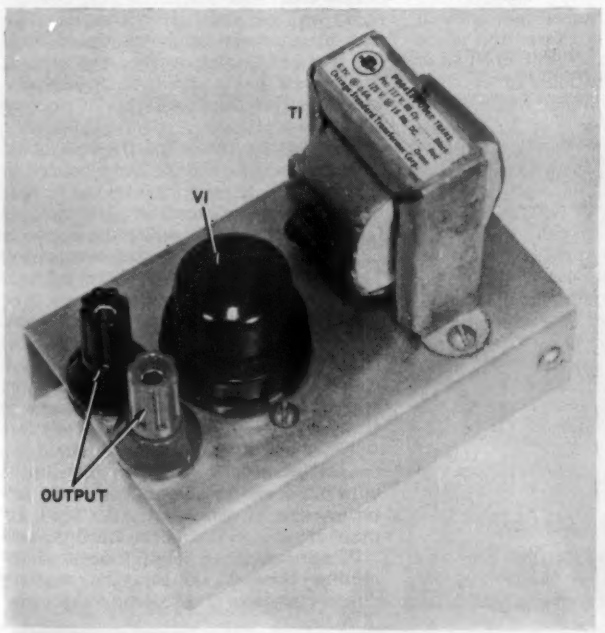
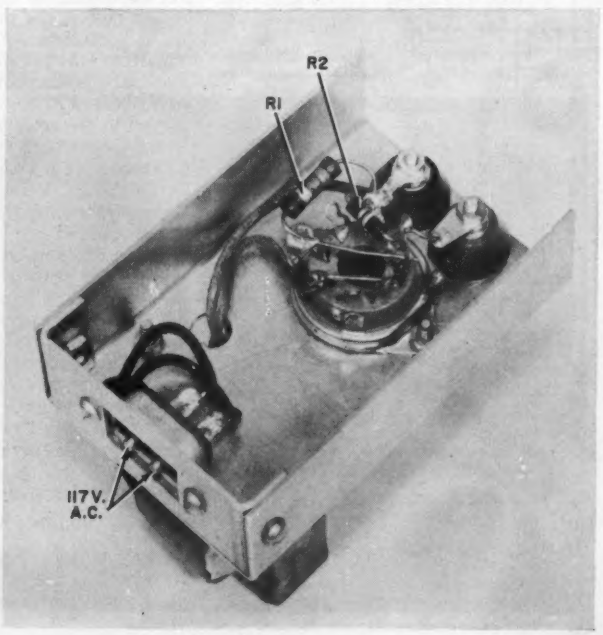


Fig. 3. Effect of circuit loading on two tubes operating at normal heater voltage.

Author used 6.3-volt secondary winding of a Stancor PS-8415 power transformer to deliver sine-wave signal to the clipper.



This under-chassis view shows the simplicity of the construction. Only two resistors, a tube, and a transformer are used.

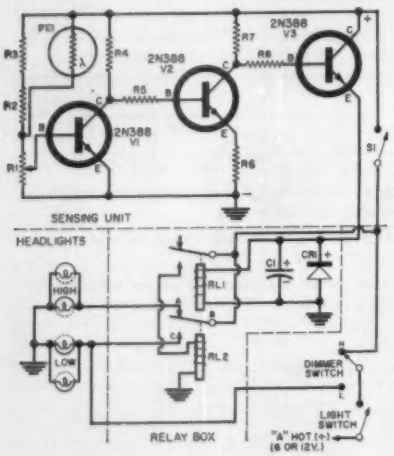


TRANSISTORIZED HEADLIGHT DIMMER

By A. J. MARTIN / Semiconductor Div., Sylvania Electric Products Inc.

Build this inexpensive accessory that dims your headlights automatically upon approach of another automobile. Circuit may be overridden by the driver.

Circuit of the photocell-operated dimmer.



R_1—50,000 ohm pot
R_2,R_3—500,000 ohm, ½ w. res.
R_4—100,000 ohm, ½ w. res.
R_5,R_8—5000 ohm, ½ w. res.
R_6—18 ohm, ½ w. res.
R_7—43,000 ohm, ½ w. res.
C_1—50 μf., 50 v. elec. capacitor (reverse polarity if "plus" side of battery is grounded)
CR_1—50 v. diode (Sylvania SR93, SR77, SR500 or 1N2069, 1N2070, 1N440B. Reverse polarity if "plus" side of battery is grounded)
RL_1—Sensitive d.c. relay with 100-500 ohm coil, pull-in current of 3.2 ma. (Author used Sigma SR-500-S)
RL_2—6-volt d.c. relay, 15 amp. contacts (for 12-volt automotive battery system use 12-volt d.c. relay)
S_1—S.p.s.t. toggle switch
PC_1—Photocell (Sylvania CDS 9M or Clairex CL403)
1—Argus "Pre-Viewer III" (see text)
1—2" x 4" x 4" aluminum box and bracket (see text)
V_1,V_2,V_3—"n-p-n" transistor (Sylvania 2N388—for "minus" side of battery grounded)
V_1,V_2,V_3—"p-n-p" transistor (Sylvania 2N404—for "plus" side of battery grounded)

WHILE automatic headlight dimmers are readily available as accessories on most premium-priced cars, many of us forego this convenience because of the fairly high price tag on this gadget.

This article will describe an inexpensive, transistorized headlight dimmer which can be built for a total cost of under $25.00. The circuit is designed to be used with either 6- or 12-volt automotive battery systems.

Because the circuit is transistorized, maximum current drain is 6.8 ma. In addition, the circuit exhibits minimum heat sensitivity, has adjustable operational sensitivity, and can be cut out when manual or floor-button control of the dimming operation is desired.

The Circuit

The main job of this circuit is to energize a relay with a very small signal—in this case that produced by a light of fair intensity. The circuit uses a cadmium sulphide photocell, whose resistance varies widely with varying light intensity, the "no-signal" resistance being on the order of 9 megohms.

One side of the photocell is connected to "A+" (using *n-p-n* transistors) while the other side is connected to one end of the 50,000-ohm potentiometer R_1. The other side of R_1 is grounded while its tap is tied to the base of V_1.

Now, by adjusting R_1 to allow approximately 5 to 8 μa. of base current to flow in V_1 (10 μa. being the "turn-on" current), this transistor is held in a cut off condition.

Since V_1 is in the "off" condition, its collector is resting at the supply potential, therefore base current flows into V_2. With base current flowing in V_2, the collector potential is approximately 0.5 volt. This potential is too low to force current through R_8 and the base of V_3, therefore the gate is closed and no collector and emitter current flows. The relays are de-energized.

In the "on," or signal, condition, the procedure is reversed.

Building the Dimmer

An *Argus* "Pre-Viewer III" slide viewer housing is used to enclose the photocell, transistor amplifier, sensitivity control, and "on-off" switch. First, strip the batteries and mounting brackets from the "Pre-Viewer." What was the illumination switch in this unit will be used as the amplifier base in the dimmer. Mount the three transistor sockets on the base and drill a hole in the bottom of the "Pre-Viewer" for the mounting bracket. This bracket must be metal as this serves as ground for the dimmer circuit.

Next, drill a ⅜" hole in the rear housing of the "Pre-Viewer" to mount the sensitivity control. The controls should be wired so that clockwise rotation increases resistance Then mount the photocell on a 1/16" x 1½" x 2" piece of Plexiglas. Drill small holes to fit the photocell's lead pins, put the pins in place, and then bend them to secure the photocell in position. A few drops of chloroform will soften the Plexiglas sufficiently to secure the photocell in this position. This base should be placed about ¾" back from the magnifying lens of the viewer.

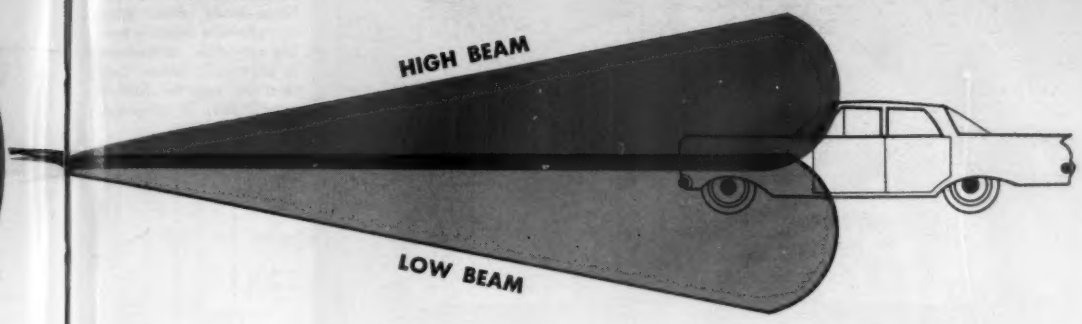
Now, mount the resistors on the amplifier and wire them in place. Next hook up the sensitivity control. The viewing unit should be mounted atop the dashboard and over to one side in such a way that it looks out through the windshield at the headlights of oncoming cars.

Now we are ready for the relay box. Two relays, RL_1 and RL_2, are housed in this box. RL_1 is energized by the output of the transistor amplifier. Its contacts feed the coil of RL_2 while the contacts of RL_2 actuate the high and low beams.

Pull-in current for RL_1 is 3.2 ma. while drop-out current is 2.75 ma. The relay box also houses the 50-μf., 50-volt capacitor and the diode CR_1, which is connected across the coil of RL_1 to suppress any reverse e.m.f. (induced by opening RL_1) to prevent damage to transistor V_2.

There are three leads from the dashboard unit to the relay box (mounted with hose clamps on the steering column)—one of which is the d.c. lead, another the RL_1 coil, and the third ground.

There are three leads lugged at the dimmer between the relay box and the dimmer switch. These leads are coded



"A", "B", and "C". Disconnect the dimmer switch and remove the high-beam lead from the switch. Using a 6/32" diameter nut and bolt, splice this lead to lead "A" from the relay box. Connect lead "B" from the relay box in place of the high-beam lead just removed. Put the "C" lead on top of the low-beam lead (there will be two leads on this leg on the dimmer switch) and remount the dimmer switch.

Testing the Unit

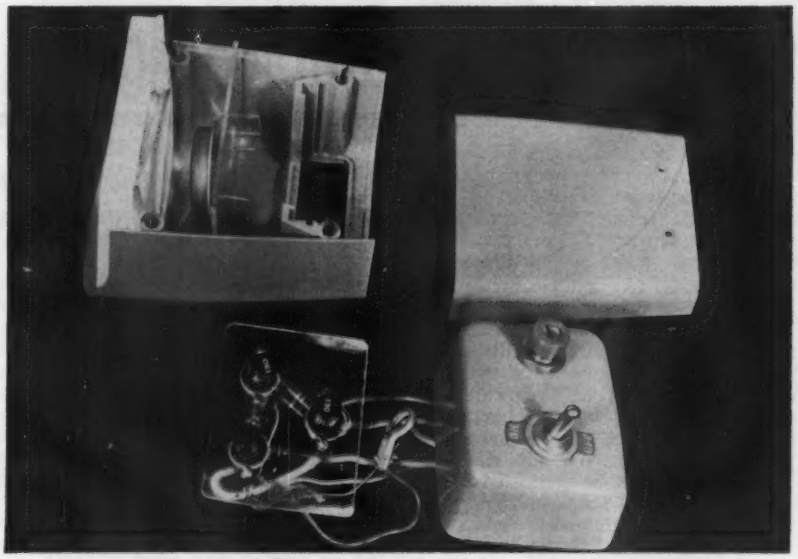
Put on the headlights and key the dimmer switch to the high beam. The unit is now on "automatic." With a vehicle coming towards you, your lights will dim automatically. If you are approaching a car from the rear and there are no cars coming from the opposite direction to actuate the dimmer, you can dim your lights as a courtesy by means of the floor button. This is the only occasion when you would have to use the floor control. After you have dimmed your lights with the floor control, switch it back to high—thus placing the dimmer control back in the automatic mode. Driving in city or town, the automatic unit will keep the lights dimmed because of the ambient light.

Adjusting Sensitivity

To adjust the unit, cover the front of the photocell to prevent any light from entering. Next rotate the control fully counterclockwise. The lights should come on high beam. Now, slowly turn the control clockwise until the lights dim, then turn the control counterclockwise until the high beam just returns. Uncover the faceplate of the photocell and you are ready for a trial run. If the light remains on low even on a dark street, you may have to turn the sensitivity control down a bit more because of the incident light from adjacent street or house lighting.

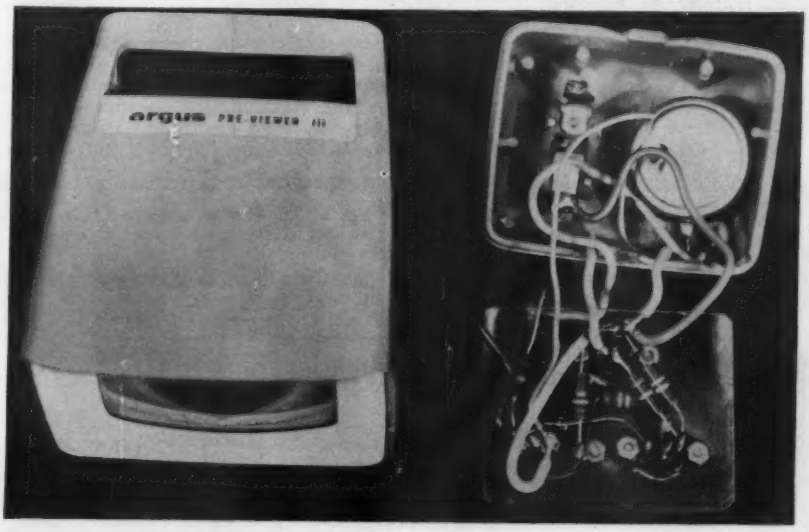
This unit, properly installed and adjusted, will perform reliably for years. One plus feature of this circuit is the fact that at no time is the driver a "slave" to this unit. Manual control can always be recaptured as required simply by depressing the floor dimmer switch.

—30—



"Pre-viewer" has been opened up to show the mounting of the photocell (top, left). Also built in is the three-transistor circuit with its sensitivity control and switch.

The assembled housing is at the left along with a close-up view of the underside of the transistor-mounting board. Connections are made to the pot R_1 and switch S_1.



Panel view of v.f.o. with home-made dial. With straight-line capacity tuning capacitor, calibration is practically linear. Calibration can be further subdivided, if required.

Ultra-Stable High-Z V.F.O.

By **ELBERT ROBBERSON,** W2FRQ

Construction of simple, inexpensive variable-frequency oscillator without critical parts or tricky adjustments.

THE IDEAL frequency-control oscillator for a transmitter should be a compact box which delivers a signal of the frequency desired with perfect accuracy from the time it is turned on until it is turned off, regardless of warm-up and line-voltage changes. It should be capable of being keyed to permit break-in c.w., without clicks or "yoop." It should be insensitive to a normal amount of shock and vibration. It should not be affected by load variations and the output should be constant over the entire tuning range, with just one tuning control. Furthermore, it should be simple and inexpensive with no critical components and no tricky adjustments.

A number of excellent oscillators come close to meeting some of these criteria, but fail in the attainment of others. The high-Z v.f.o. comes close to perfection on all points.

Principle of Operation

A high-quality coil and capacitor will stay on frequency perfectly if the circuit is not under changing load or subject to movement or heat. Fig. 1 shows what we subject the tuned circuit to in a conventional oscillator circuit. The author has used the Hartley circuit as an example; the Colpitts hookup operates similarly, except that the cathode is connected to a tap between capacitors across the tank coil instead of being tapped directly to the coil.

What this oscillator amounts to is a class-C amplifier. It oscillates because power is fed back positively from the cathode-plate circuit to the grid circuit *via* the autotransformer coil connection. Grid bias is developed across *R* by the rectification of positive input peaks of power applied to the grid of the triode tube used.

In this circuit, the coil is heavily loaded by the grid-current drain, the plate load, and the tube electrode capacitances. Changes in output load, tube voltages, tube electrode capacitances, and temperature seriously affect frequency stability. If we could separate the tube grid from the coil by a very high impedance (Z), as shown in Fig. 2, the influence of the tube would become very much less. Now let us see how this may be accomplished.

This is done by the circuit of Fig. 3A. The portion of the circuit within the dotted line is the well-known cathode-follower, which has an extremely high input impedance. Voltage developed across its load resistance in the cathode is fed to the grid of the second tube; and, *via* its cathode, the second tube supplies the tank with feedback power to sustain oscillations. Cathode resistors bias the tubes for class A1 operation, so that no grid current is drawn. Thus, the frequency-determining tank circuit is substantially isolated from outside electrical influences.

Decoupling can be additionally increased by tapping the external circuits across only a small portion of the coil, as shown in Fig. 3B. It is possible to obtain oscillation with the tubes con-

Fig. 1. The basic oscillator circuit has a substantial load on its LC tank.

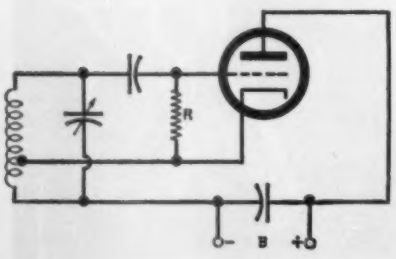


Fig. 2. The tube is separated from the tank circuit by an isolating impedance.

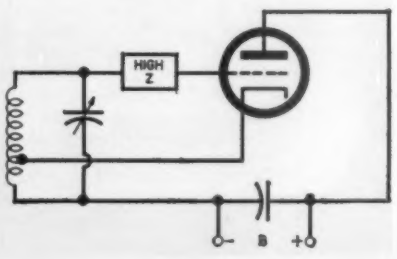
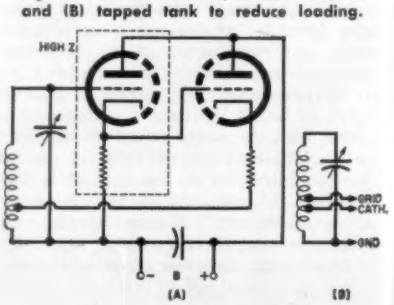
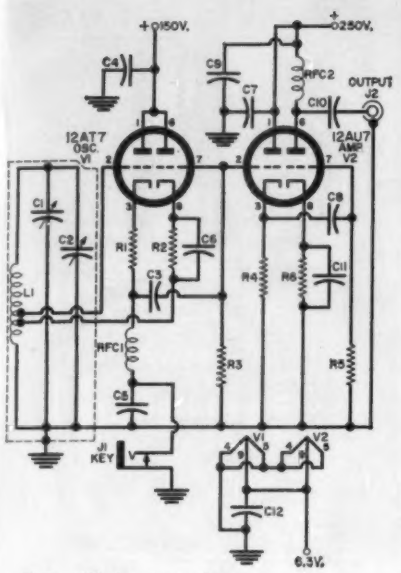


Fig. 3. (A) The use of a cathode-follower and (B) tapped tank to reduce loading.





R_1,R_2—470 ohm, 1 w. carbon res.
R_3—470,000 ohm, 1 w. carbon res.
R_4—2200 ohm, 1 w. carbon res.
R_5—100,000 ohm, 1 w. carbon res.
R_6—1000 ohm, 1 w. carbon res.
C_1—100 μμf. double-spaced, two-bearing var. capacitor (Hammarlund MC-100-SX)
C_2—35 μμf. double-spaced, two-bearing var. capacitor (Hammarlund MC-35-SX)
C_3,C_6,C_8,C_{10}—1000 μμf., 500 v. mica capacitor
C_4,C_5,C_7,C_9,C_{11},C_{12}—.01 μf., 500 v. disc ceramic capacitor
L_1—24 t. "Airdux" 1610-T, 2" dia. (grid tap at 3-5 t., cathode tap at 2-3 t. from ground end, see text)
RFC_1,RFC_2—2.5 mhy. r.f. choke
J_1—Closed-circuit jack
J_2—Coax jack
V_1—12AT7 tube
V_2—12AU7 tube

Fig. 4. Practical high-Z v.f.o. circuit.

nected to as little as 10% of the coil. This combination of isolating factors allows the tank to retain most of its unloaded high-"*Q*" and frequency stability.

Practical High-Z V.F.O. Circuit

Fig. 4 shows a practical circuit for using the high-Z oscillator as a v.f.o. Because maximum stability results when oscillator power is low (to minimize circuit heating), the oscillator operates at a low power level and an amplifier is used to bring the output up to a value high enough to drive a moderate-power transmitter. The amplifier also isolates the oscillator from succeeding circuits.

The circuit of the 12AT7 oscillator tube is the same as that of Fig. 3, with the addition of components required to permit cathode keying and to provide the best values of operating bias. The first half of the 12AT7 is a cathode-follower amplifier with its grid tapped across a small portion of the tank coil, L_1, so that the tank is practically without load and the tube grid capacitance has small effect on the tuning. R_1 supplies cathode bias for class A1 operation of the tube, so that grid current is not drawn. The r.f. choke RFC_1 is the load impedance for the amplifier. C_5 is just an r.f. bypass for the keying circuit.

The second half of the 12AT7 supplies feedback, receiving its excitation from the voltage developed across the tank-amplifier cathode choke, RFC_1, through the d.c.-blocking capacitor, C_3. This, too, operates as a class A1 cathode-follower, with grid bias provided by R_2, which is bypassed by C_6. The r.f. feedback voltage is developed across the bottom portion of the tank coil and, by autotransformer action, is applied to the tank-amplifier grid. The purpose of C_6 is to allow a good portion of the r.f. voltage to appear in the tank-coil section instead of mostly across the bias resistor. Note that the cathode resistor for the first tube section, R_1, is not bypassed. This prevents the small portion of the tank coil tapped across from "taking off" as a parasitic v.h.f. oscillator.

The biasing resistors and the position of the coil taps are chosen so that both sections of the 12AT7 draw as close to the same plate current as possible whether oscillating or not.

The amplifier is a 12AU7, the first half of which is a cathode-follower, to minimize loading on the oscillator. It also receives excitation from the cathode circuit of the tank-coil amplifier through C_3. The second half of the 12AU7 is a voltage amplifier, delivering the output voltage developed across the plate r.f. choke, RFC_2, through coupling capacitor C_{10}. The 12AU7 is also biased (by its cathode resistors) for A1 operation so that grid current is not drawn and plate current is the same whether the oscillator is keyed or off.

Construction

The v.f.o. illustrated was built for the excitation of c.w. or phone transmitters on the 3.5- and 7-mc. bands and, followed by a harmonic amplifier, the higher frequency bands. With the components chosen, fundamental operation is on the 3.5-mc. band, harmonics being picked off for higher frequencies.

Since the frequency stability is primarily governed by the "*Q*" of the tank coil, L_1, great care was taken in the selection of this coil. Coil dimensions were determined by a process of pruning and measuring the "*Q*" of a commercial "air-wound" coil over a broad range of frequencies. The dimensions chosen were 24 turns of No. 16 tinned copper wire with a winding pitch of ten turns-per-inch, and 2" diameter. This gave a "*Q*" of 400 peaked in the 3.5-mc. band.

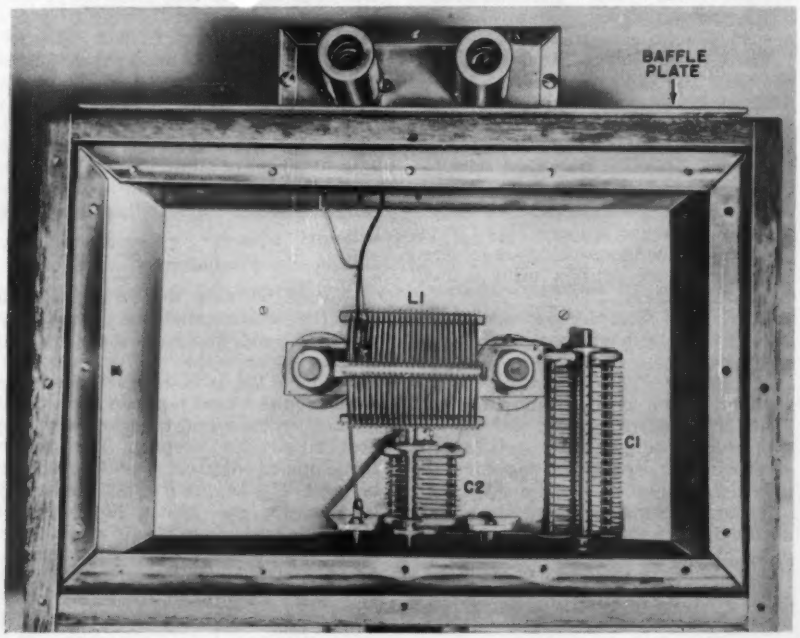
The tank circuit requires a parallel capacitance of a little over 100 μμf., most of which is provided by a 100-μμf. bandset capacitor with a 35-μμf. capacitor in shunt for tuning. Two-bearing, double-spaced capacitors were used for maximum stability.

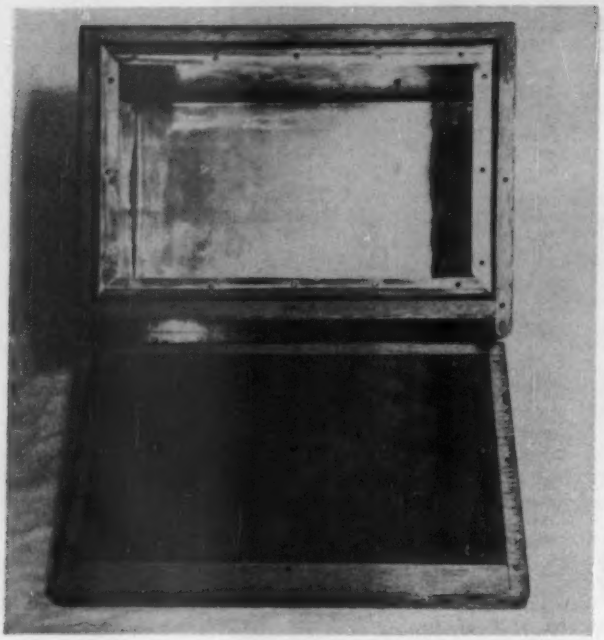
Having chosen tank-circuit components of the highest efficiency, every effort was made to retain it. The means the tuned circuit must be enclosed in a fairly large shield with as little extraneous matter as possible in the enclosure. All heat- and loss-producing components must be located outside.

The first version of the high-Z v.f.o. was constructed around a stock aluminum cabinet with coil and tuning capacitors inside, and the tube sockets mounted outside one wall. Performance was very good for a short period of time until tube heat began to change the cabinet wall temperature. A slow drift commenced after five minutes operation from a cold start, stabilizing 150 cycles low in frequency after 30 minutes. This indicated that it would be possible to obtain more accuracy by isolating the tuned circuit from heat sources, as well as from electrical effects.

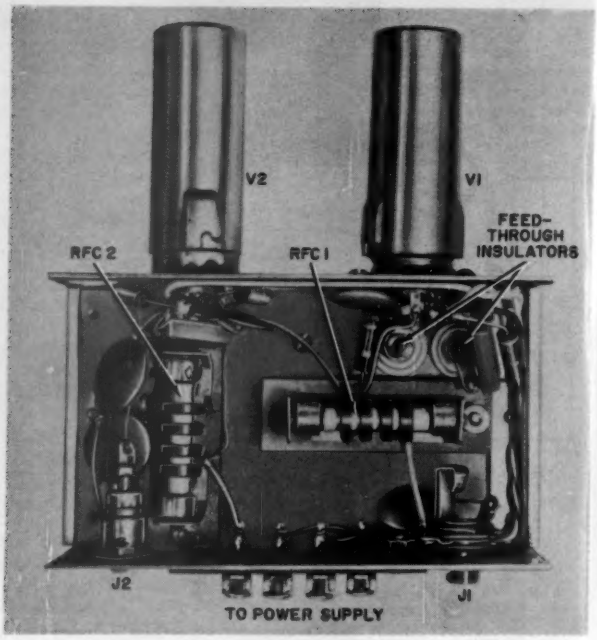
Thermal isolation could be obtained by just building the coil and tube circuits in separate shields with the least path between them for thermal con-

Top view of uncovered v.f.o., with tuning capacitor in center and bandset on right. Aluminum baffle plat tween coil box and tube unit reflects and dissipates heat.





Oscillator tuned circuit is protected by wooden box and copper shield. Copper plate on cover is screw fastened to top flanges of shield. Two holes in back are for the feedthrough insulators.



Placement of parts in tube compartment. At right is 12AT7, with 12AU7 amplifier at left. Jacks are for output and key. Note feedthrough insulators for grid and cathode leads into coil box.

ductivity. This could be done by using conventional stock components.

However, changes in ambient values, as when room temperature or adjacent equipment heat rises, would still cause drift. This can be reduced to the point where it is of no practical consequence by thermal shielding of the v.f.o. tank.

A very simple method of heat insulating is to enclose the oscillator tuned circuit and its shield in a wooden box. The author chose a shielding enclosure measuring 7" x 7" x 11" as being reasonable in size and yet not reducing coil "*Q*" by more than a few per-cent. A wooden box having these inside dimensions was built to house the shield. Half-inch soft wood is very easy to work and has good heat-insulating qualities.

Three linear feet of 14" flashing copper from the local hardware store was used to line the wooden box and the detachable cover. One piece was cut 22" long x 12" wide to form the back, bottom, and front of the shield, with ½" flanges bent over at the top and sides for fastening. Two pieces, 7" x 7", are used for ends and a piece 7" x 11" for the top. The copper shield was soldered together outside the box, using a small canned-gas torch.

The shield was secured inside the wooden box by a sufficient number of small wood screws to keep the copper from flexing. The shield cover was screwed to the wooden top of the box. Holes are drilled through the top into the shield flanges and self-tapping screws can be used to pull the shield top into tight contact with the sides.

The coil is cemented to a 1"-wide strip of Plexiglas and mounted on ceramic pillar insulators so it is centered within the enclosure. The tuning and padding capacitors are secured inside the front panel. A special dial was built around a surplus *National* "Velvet Vernier" unit, but any of the commercial ready-made dials could be used. Since only two controls are necessary—bandset and main tuning—the panel was unbalanced, so a dummy knob was installed on one side just for looks. This extra knob could be used for some other purpose, such as an "on-off" switch, but it would have to be completely shielded.

The tube circuits were installed in a 5" x 3" x 2⅛" cabinet. Two small ceramic feedthrough insulators, with short flexible leads and coil clips, project through the rear of the cabinet and into the wooden box for the grid and cathode connections to the coil, while the ground is a screw connection through from the cabinet into the coil shield. The r.f. chokes are mounted at right angles to prevent intercoupling, and tie points hold the ends of all wiring and parts that are not otherwise well supported. Before mounting the tube enclosure, a 7" x 10" sheet of aluminum was secured to the back of the wooden coil box to reflect tube heat and further isolate the coil.

Adjustment

Anyone building this oscillator will find the adjustments more fun than work. As a starting point, tap the oscillator grid lead to the coil five turns from ground and the cathode lead three turns from ground. These taps can be adjusted a small amount at a time to obtain the best output and keying. The fewest turns giving desired operation should be used. The keying can be checked by listening to the 28-mc. harmonic; it should be possible to obtain a practically chirpless signal even with this degree of frequency multiplication. When the v.f.o. is properly tuned, the plate current of all tubes should remain constant with the key down and the oscillator "killed" by touching the "hot" end of the tank coil. If it does not, try small changes of cathode resistance and re-adjust the coil taps.

If oscillator keying is not essential for break-in (as it might not be if you have done a good job of shielding and bypassing), the oscillator can be left running during transmissions; or if it is keyed by a relay in the 150-volt "B+" line, the circuit can be changed slightly to give even less coil loading. In this event, the bottom end of r.f. choke RFC_1 can be grounded. C_2 and R_2 can be omitted and the grids of the second half of the 12AT7 and the first half of the 12AU7 can be connected directly between R_1 and RFC_1. With this connection, grid and cathode taps on as little as three and two turns of the coil will provide excellent operation.

With the tuning dial at maximum capacity and the bandset capacitor set to 3.5 mc., the v.f.o. tunes from 3.5 to 3.9 mc., with a practically linear scale. The bandset can be adjusted so that coverage includes the entire 75-meter phone band, if desired, at the expense of 100 kc. of the c.w. band. The bandset can be moved between the two points to give full 75-80 meter coverage. Once the bandset is adjusted, the tuning dial is as reliable as a frequency meter and calibration can be carried down to any subdivision the dial itself is capable of reproducing.

Performance

The r.f. output on 3.5 mc. is five to ten volts, the exact value depending upon adjustment. This is sufficient to drive the usual moderate-power transmitter or exciter. Output is substantially constant over the entire tuning range of the

(*Continued on page* 81)

FROM THE GENERAL ELECTRIC COMPANY

6 answers—with some long-range meaning for Engineering Writers

Q Is this message published in an effort to hire Engineering Writers? If so, does it also include Technical Writers?

A **Yes, General Electric has openings for professional Engineering Writers in its Heavy Military Electronics Department. Most of these are new openings, based on Department growth. But while inquiries from Technical Writers would be welcome, these particular openings are for Engineering Writers only.**

Q So there is no misunderstanding, will you pinpoint the difference between the Engineering Writer and the Technical Writer in your organization?

A **It is in the degree of technical competence required. In our organization, the Engineering Writer is a professional in the full sense of the word—with a technical competence approaching that of the Design Engineer with whom he so closely works. HMED's Engineering Writers either have their BSEE's or the equivalent in experience and training.**

Q What is the nature of the work?

A **If qualified, you'll be assigned to one of the major electronic systems programs for which the Department is responsible. For example, you might be assigned to the Navy SQS-26 program—involving the most powerful shipborne sonar in the free world. Or it could be to a project designed to monitor all activity in millions of cubic miles of ocean. And these are but two . . . .**

Q What functions are involved?

A **You'll be providing the first "translation" of the raw material (i.e. graphs, schematics, charts, etc.) produced by the Design Engineer into manuscript form. From your manuscript and under your direction, support personnel provide publications covering systems philosophy, installation, operation, and maintenance for use by military customers.**

Technical competence is the vital qualification here. Certainly your writing talent is valuable, but in terms of major electronic systems—we need your technical competence. That's why even though you have responsibility from start to printed material, your support personnel take care of finished writing, illustrating, and printing.

Q What are the qualifications?

A **You could be qualified in either of two ways:**

1. If you have your BSEE and experience in our product line, you are probably qualified.

2. But we would also strongly consider an E.C.P.D.—accredited Technical School graduate or a man with two or more years' credit toward his BSEE. But in this case, you must have also had the following military experience:

2 or more years' maintenance or repair of major electronic systems, specifically radar (land-based or shipborne), computers (fire control or GCI), or sonar.

Q Assuming I qualify, would it really be worth a job change?

A **Yes—if you are looking for greater professional opportunity. In the first place, you'll be treated (and expected to contribute) at a high level. Also, you'll be joining an organization within G.E. that continues to grow. The technical writing staff has grown by 700% in the last eight years and there is no let-up in sight. Obviously, this means you are joining a Department that needs your talent—and the need will continue into the foreseeable future.**

More information about General Electric's extensive benefits program is available upon request. Relocation assistance will be provided. Qualified personnel will be invited to Syracuse for interviews at Company expense. All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin. 178-01

FOR MORE INFORMATION, *send a summary of your background and experience in confidence to:*

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Kit AS-21U, unfin..**$224.95**

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Kit MI-10 $7 dn., $7 mo.**$69.95**

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Deluxe features at minimum cost. Covers 200-400kc beacons, 550-1600 kc broadcast, 1700-3400 kc marine band. Loop and "sense" antennas eliminate double null. 9-transistor circuit, battery powered. Pre-assembled tuning unit.

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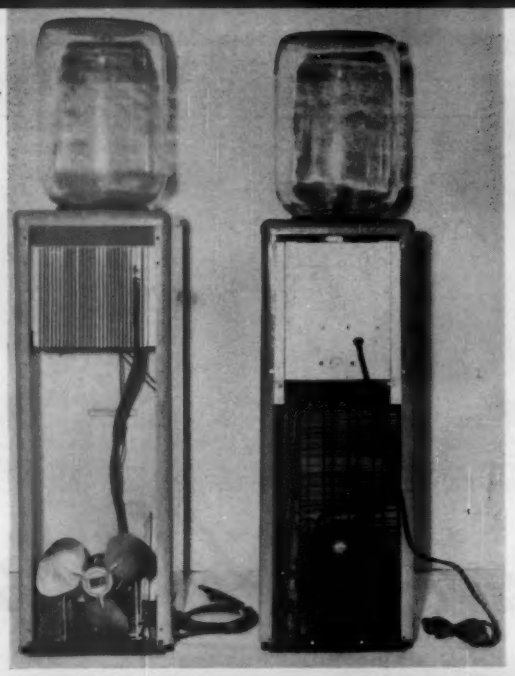
Recent Developments in Electronics

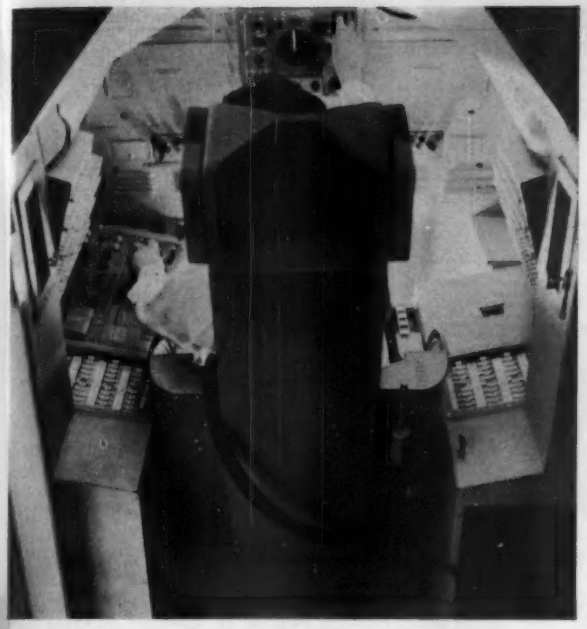


Thermoelectric Water Cooler ▶
This photograph compares the inside cabinet areas of the new *Westinghouse* thermoelectric water cooler, left, with a conventional unit, right. The cooling components in the thermoelectric unit require 25 per-cent less volume than those in a standard compressor-operated unit. Except for the fan at the bottom used to dissipate the heat drawn from the cooling elements, there are no moving parts in the thermoelectric cooling system. At right, the conventional cooler includes a "network" heat-exchange system, in addition to the traditional motor-driven compressor. The 36-inch cabinet height has been retained in the new cooler because it places the water tap at a convenient level.

Electronic Display Panel ▶
An electronic panel less than one-half inch thick that uses a new principle to produce a moving, lighted image was described recently by *General Telephone & Electronics Laboratories'* scientists. In the panel, piezoelectric material produces a moving electric charge that actuates a layer of electroluminescent material to produce a moving, luminous display.

◀ **Magnetic Sorter**
Relying entirely on the information magnetically recorded on each plastic jacket, this prime sorter in *Valley National Bank's* document-handling system in Phoenix, Arizona, separates checks into 26 pre-programmed groups. The device, part of an *ITT*-developed installation, handles 25,000 jackets an hour. High-volume items, such as payroll accounts, dividend checks, clearing-house items, and accounts with large correspondent banks are assigned pockets.

◀ **Lightweight Airborne Teleprinter**
A U. S. Marine carries two compact, lightweight teleprinters to the helicopter in the background for installation in the aircraft. The teleprinter, developed by *MITE Corporation* of New Haven, Conn., is part of a send-receive communications system used to maintain reliable contact between air and ground crews through radio relay or wire circuits.



Jet Bomber Flight Simulator

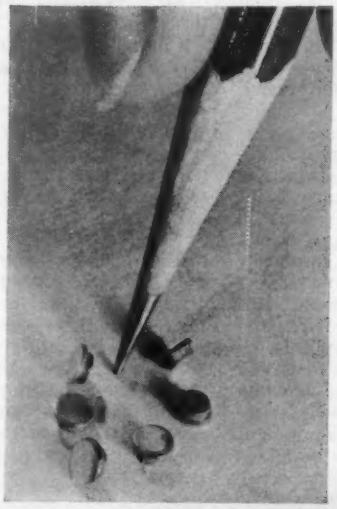
Strapped into ejection seat, defense officer of USAF's B-58 jet bomber "flies" mission in complex electronic flight simulator at Carswell Air Force Base, Texas. The B-58 trainer, designed and built by *Reflectone Electronics, Inc.*, Stamford, Conn., provides actual aircraft environment, complete to the last detail—a drinking tube from the overhead water container. Students develop electronic-countermeasure techniques under simulated combat situations in complete instructor-controlled on-the-ground safety. Heart of the simulator is a labyrinth of computers and target-generation systems which produce special signals imitating ground-based radar and airborne targets.

10,000-mc. Tunnel Diodes

Sylvania will produce and market these miniaturized tunnel diodes, which oscillate at frequencies of 10,000 mc. and above. The new units operate at three times the range of previously announced tunnel diodes and are particularly useful in solid-state X-band oscillators and amplifiers which do not require pumping.

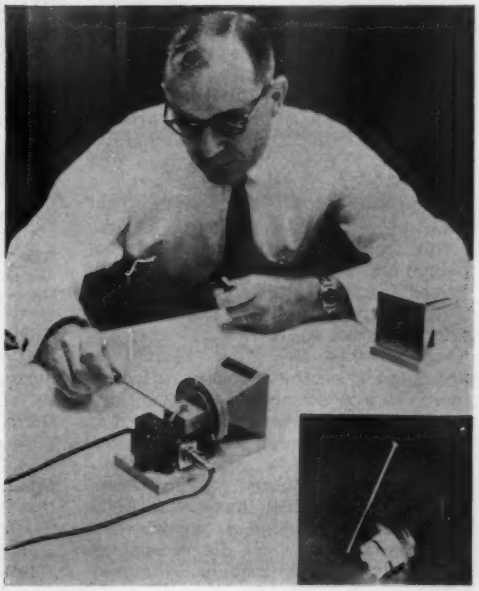
World's Biggest Horn Antenna

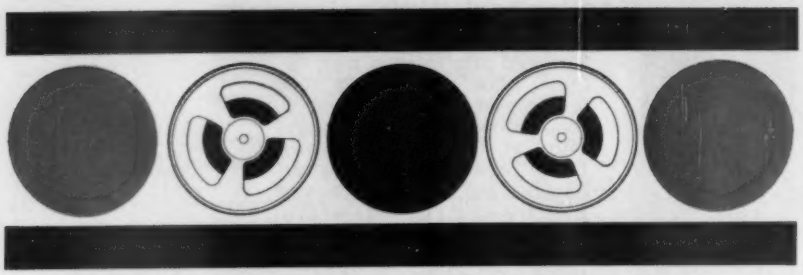
Artist's drawing of the *Bell System's* antenna being built near Rumford, Maine for experiments in overseas satellite communications. The antenna will be protected from the weather by the largest inflated radome yet made, 210 feet across and 161 feet high. The giant experimental horn antenna will transmit and receive signals that carry transatlantic telephone calls, live television, and other communications *via* orbiting satellites. (For further details on this type of system, see "Sugar-Scoop Antenna" in our November, 1960 issue.)



X-Band Transmitter

Photograph below shows adjustments being made on a miniature transmitter that uses a single miniature ceramic receiving tube, the *G-E* type 7486. The tube (inset) is dwarfed by a common pin. The transmitter, feeding its output into a small radiating horn, operates at a frequency of 7300 mc. A matching receiver is shown at the right. Power output is 30 mw. and range is 50 feet, or much greater, depending on receiver sensitivity. The demonstration shows that signals at this frequency can be produced with a relatively inexpensive tube-cavity combination.





RECORD & REEL REVUE

By BERT WHYTE

HOW OFTEN have you listened to some ancient recording of a noble performance of some great work by a famous conductor, now long dead, and said to yourself . . . "Boy, oh boy, wouldn't that have been sensational if it had been recorded in stereo"! Needless to say this is idle thinking applied to such giants as Furtwangler and Mengelberg and others of similar lustre. Of course stereo was virtually non-existent in those days, with only the obscure experiments of Dr. Blumlein of *EMI* the first faint flicker of light on the stereo horizon.

The real tragedy of this stereo age is the case of the late, great Arturo Toscanini. It was at the twilight of his career when *RCA* began to experiment with stereo and although there was one actual stereo recording made, it is evidently considered too flawed to permit release. A somewhat sad and puzzling aside is that as late as February 1953, recordings were being made with the Maestro without stereo. I say this because at that time I had been recording stereo for over three years, and the equipment to record stereo was available in 1953. Admittedly, the equipment was not as sophisticated as we have today, but it was capable of recording true stereo sound of remarkable quality. An offer I made to record the Maestro in stereo in 1952 was rejected without comment.

All the foregoing is in preface to the recent release of three famous Toscanini performances in a new sound process *RCA Victor* calls "Electronic Stereo Reprocessing." With much fanfare and flurry of press releases, *Victor* details a method wherein the end result is that these venerable Toscanini monophonic recordings are imbued with "stereophonic characteristics." To their credit, *Victor* frankly admitted that sales of Toscanini recordings had fallen off considerably since the advent of stereo and whether this Toscanini revival is prompted by aesthetic considerations or more crassly commercial reasons, these would appear to be merely the first in a series of "electronic stereo reprocessings."

There are undoubtedly many recent converts to classical music who know of the Toscanini legend but who are quite unfamiliar with his recordings. Since most of these people are stereo-oriented, they usually want the most modern version of a given work, recorded with the most up-to-date technique. This would almost automatically preclude consideration of the Toscanini recordings as they existed in monophonic format. Thus *Victor* quite rightly assumed that any updating of the Toscanini recordings would somehow have to be worked out to include use of the term "stereo."

From a strictly purist viewpoint, you record stereo from the outset since there is no such thing as a post-recording method of obtaining stereo; from a sales viewpoint, the term "stereo" is conveniently "stretched" and altered in meaning. Unfortunately, although *Victor* is careful to spell out its experiments as "electronic stereo reprocessing," most of the public and a great deal of the press . . . even some of the hi-fi press who should know better . . . have already dropped the other terminology and simply refer to these recordings as "stereo." In other words, to a public which is already confused enough with *bona fide* stereo, the problem is compounded by calling these manipulated monophonic recordings "stereo," which I assure you they are not! And now to the recordings themselves:

DVORAK
SYMPHONY #5
NBC Symphony Orchestra conducted by Arturo Toscanini. Victor LME2408 ESR. Price $4.98.

RESPIGHI
THE FOUNTAINS OF ROME
THE PINES OF ROME
NBC Symphony Orchestra conducted by Arturo Toscanini. Victor LME2409 ESR. Price $4.98.

MOUSSORGSKY-RAVEL
PICTURES AT AN EXHIBITION
NBC Symphony Orchestra conducted by Arturo Toscanini. Victor LME2410 ESR. Price $4.98.

All three recordings share the genius that was Toscanini. One listens to the incandescent energy, the vibrant intensity of expression, the brisk unflagging tempi, the masterful shaping of line and phrase in these performances and wonders from what deep wellspring within this man comes the stupendous vitality that belies his great age. These are great musical experiences and, quite apart from any technical controversy, it is fitting that they have been issued—for the benefit of those to whom the art of Toscanini is a bright and shining new experience and for old friends and admirers whose original recordings have long since become too worn or perhaps broken.

According to *Victor*, not all old recordings are suitable for this electronic stereo reprocessing. It is significant that the three initial recordings chosen represent the cream of Toscanini's output from the standpoint of monophonic high-fidelity quality. An attempt was made to apply this new process to the Maestro's great recording of the Beethoven 9th, but at least for the present, too many difficulties were encountered.

There is nothing essentially startling about the electronic stereo technique . . . the nominal seating of today's symphony orchestra aids the procedure greatly since the lighter, higher-toned instruments, *i.e.*, the first and second violins, are placed to the left of the conductor and the darker-hued celli and contrabassi to the right. A simple frequency-dividing network, sending highs to left and lows to right, results in a certain degree of channel differentiation, but obviously not without serious imbalances and impairment of perspective. Thus a series of more complex filters of varying cut-off frequencies were used, along with such standard practices as cross-insertion and attenuation phase inversion and variable time-delay techniques.

My good friend Bob Darrell wrote the jacket notes for these recordings and he gives a very detailed and lucid explanation of the technique for those who are interested. Suffice to say that the obvious goal of all this filtering and finagling is to approximate a stereo recording, with perhaps the aspects of directionality the most important. This makes commercial sense at least, because in the public mind, directionality is the most immediately apparent phenomenon they associate with stereo. Also desirable, of course, is the achievement of depth effects which, in turn, are allied with that rounded spaciousness of acoustic climate which is characteristic of stereo.

How effective is this pseudo-stereo called "electronic stereo reprocessing"? Let me preface my answer to this by saying that I have seen a number of reports on these recordings, in which the critic gets caught up in the trap of comparing the original mono versions with the *"stereo,"* as the new discs are already being called. Further, many of them purport to hear varying degrees of directional effects and one even went so far as to state that he found the recordings comparable to the average stereo quality of today's *Westrex*-type discs!

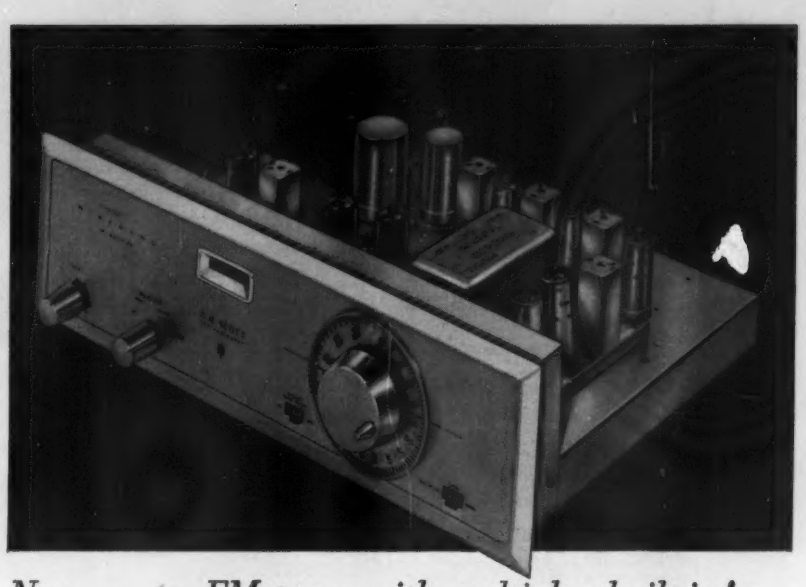
I can't conceive what kind of equipment these discs were played back on, or what state of balance and repair this equipment was in or what acoustic environment it was in, to produce such conclusions. My evaluations were made between the new recordings and the original mono versions and with prime stereo examples of each work, after my

system had been completely checked out and balanced. Here is my analysis: On all three discs directional effects were practically nil. For the most part, the first violins were heard in the middle phantom channel or slightly to the left of middle. In a few instances, where the first strings just happened to be playing an isolated passage themselves, or with a minimum of other instrumental interference, a somewhat more pronounced localization to the left was evident. Much the same held true for the celli and bass; woodwinds and percussion were nicely centered in the phantom-center channel and since this is more or less standard in stereo, was not objectionable. Trumpet, trombone, and french horns were very static and stayed with little variance in the phantom center or slightly left or right of center.

Depth effects were minimal at best. As far as I am concerned, most of the information I received was contained between my speakers. How any person possessed of a truly good ear and with good stereo equipment, could mistake these discs for real two-channel stereo is a mystery. A very easy test of these reprocessed discs (to quickly differentiate them from stereo) is to sit at the optimum point between your speakers and then bend from one side to the other so that you alternately favor the left and the right side. In addition to noting the preponderance of information in the phantom center, as you quickly bend from one to the other speaker, you will notice that essentially the same information is coming out of both speakers! Perform this same test with a top quality stereo disc made from a three-channel master and you will perceive, for example, that if trumpets and trombones are sounding out on the right and first and second strings and perhaps french horn in the left, you will hear the trumpets and trombones to the right with *little if any trumpet and trombone sounding in the left speaker* and *vice versa* for the strings and french horn.

You may well ask at this point, if these "electronic stereo reprocessed" discs have any virtues. The answer is yes. The reverberation characteristics have been changed so that there appears to be more air around the sound . . . it is more spacious without reaching the quality imparted by true stereo-spaciousness. The individual instrumental timbres are reproduced, often with a distinct gain in clarity. On an over-all basis, as there have been considerable advances in cutting techniques since the originals were issued, the sound is generally cleaner and brighter, some distortions which existed (for example the finale of the "Pines of Rome") have been cleared up. Dynamic range is satisfactory except in the very biggest climaxes where a definite sense of compression is felt. Background noise is a little high, mostly from tape hiss due to the repeated overdubbing necessary in this type of process.

In summation, these reprocessed Toscanini discs are a welcome upgrading in certain sound qualities and I hope will afford much enjoyment to many people



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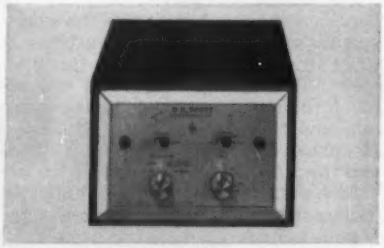
* * *slightly higher West of Rockies.*



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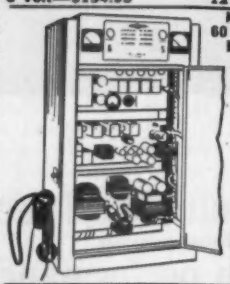

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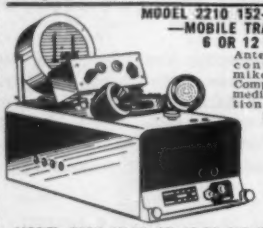

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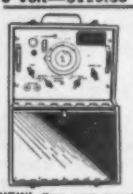

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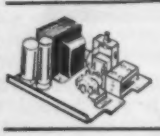

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who might otherwise have never heard these superlative Toscanini performances. It is also to be hoped that responsible people will stop categorizing them as stereo discs and use some less confusing nomenclature. Great music they are . . . stereo they are not!

PROKOFIEV
PIANO CONCERTO #3
MACDOWELL
PIANO CONCERTO #2

Van Cliburn, pianist, with Chicago Symphony Orchestra conducted by Walter Hendl. Victor LSC2507. Price $5.98.

This is a good vehicle for the talents of the remarkable Van Cliburn and if you like your piano concerti in the big, bold, bravura fashion, you'll certainly enjoy this disc.

The Prokofiev is a marvelous work, a favorite of mine and I shall never forget the performance I heard by the late William Kappell with Rafael Kubelik and this same Chicago Symphony. Van Cliburn takes a broader, more romantic approach to the work, and within this concept plays beautifully. But he lacks the crisp incisiveness, the dynamic expression, and the somewhat sardonic humor with which Kappell imbued the work.

The MacDowell is a rouser, romantic to the core, and played by Van Cliburn with tremendous vitality and technique. The sound is good in both cases, the piano in the Prokofiev projected a bit farther forward than in the MacDowell. Directional virtues and depth perspective were more than satisfactory and dynamic range pleasingly wide. The famed acoustics of Orchestra Hall were well-handled and contributed a fascinating amalgam of spaciousness with rock-ribbed instrumental timbres.

BIZET-SARASATE
CARMEN FANTASY
SARASATE
ZIGEUNERWEISEN
SAINT-SAENS
HAVANAISE
INTRODUCTION & RONDO CAPRICCIOSO

Ruggiero Ricci, violinist, with London Symphony Orchestra conducted by Pierino Gamba. London CS6165. Price $5.98.

The "Zigeunerweisen" and the Saint-Saens works are played very ably by Ricci, perhaps with not quite the suaveness or elan that some others bring to these scores. The prize here is the "Carmen Fantasy," wherein Ricci unloads his formidable technical armamentarium and takes a back seat to no one. His pyrotechnics are positively dazzling and the smooth ease with which he traverses some of the incredibly high harmonics is something at which to wonder. If your taste for Carmen has been dulled by endless repetition, here is a fresh approach which will whet your appetite. Not the least of the attractions of this piece is the really spectacular sound, some of the best from *London* in a long time. It is very wide in frequency response and dynamics and, although the very close-up miking affords tremendous presence, the acoustics are very spacious.

The directivity is more pronounced here than in most *London* recordings and this plus the over-all brilliance of the sound leads me to suspect that *London* is now using the three-channel approach or some variation thereof.

HAYDN
MASS IN TIME OF WAR

Netania Davrath, soprano; Anton Dermota, tenor; Hilde Rossl-Majdan, alto; Walter Berry, bass; with Vienna Chamber Choir and Vienna State Opera Orchestra conducted by Mogens Woldike. Vanguard VSD2075. Price $5.98.

This is one of the most thrilling Masses ever written, combining the soloists, chorus, trumpets, and tympani in a wonderful display of antiphonal and, therefore, highly stereo-istic scoring. Woldike is a Haydn scholar of formidable stature and his reading is entirely sympathetic and authoritative. The soloists are old hands at Masses and oratorio and sing their parts with spirit and conviction. The orchestra is actually the great Weiner Philharmoniker, a fact easy to perceive from the fine playing and the assured manner in which the trumpeter handled the fiendishly difficult high passages.

The sound is good, appears to have been recorded as a two-channel master, but with excellent balances. The choir, soloists, and orchestra are mutually respectful and are nicely integrated. Dynamic range and frequency response were quite wide and all was big and clean save for some occasional blasting in massed choral passages.

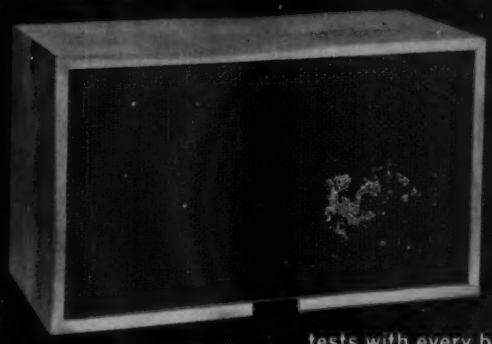
HARRIS, ROY
FOLKSONG SYMPHONY 1940

American Festival Chorus and Orchestra conducted by Vladimir Golschmann. Vanguard VSD2082. Price $5.98.

Among the most talented and genial of our American composers is my friend Roy Harris. He is justly celebrated for such works as his 3rd, 5th, and 7th symphonies, yet to me the man is best epitomized by his wonderful "Folksong Symphony."

This joyful, heartfelt outpouring is certainly idiomatic, with Roy's boisterous and bountiful Americanism waving like a flag in the wind. The work cannot be simply dismissed as a seven-movement collection of folksongs. True, Harris has made free use of folk material, but this is the only part that is derivative; the rest is inspirational . . . and professional and abounds with rhythmic vitality and melodic invention. Thus this heady amalgam is composed of one part Roy Harris and one part tunes like "The Girl I Left Behind Me," "O Bury Me Not On The Lone Prairie" and others, ranging through the seven movements and ending up with the ebullient "Johnny Comes Marching Home."

Golschmann conducts the work with a great deal of sincerity and respect and yet my impression is that he and the chorus and orchestra had a lot of fun recording this piece. The orchestration is as colorful as the material and the choral parts beautifully executed.



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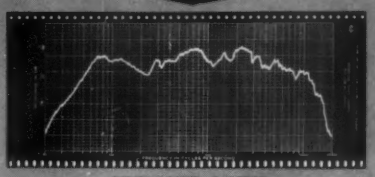

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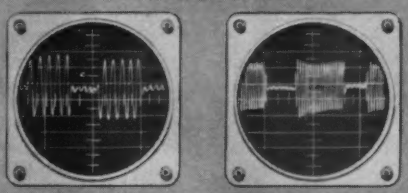

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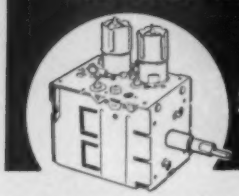

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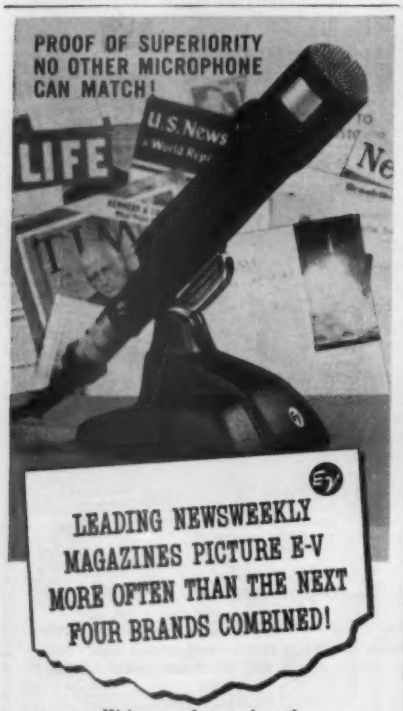

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Soundwise this is topnotch, with a fine balance maintained between chorus and orchestra. The directional and depth effects were easy to perceive, and the over-all recording is notable for its clean sonic contours. An occasional spot of choral "blur" intrudes now and then in an otherwise splendid recording. This is the sort of songful, foot-tappin' piece that, given reasonable circulation *via* this recording, is certain to achieve broad popularity. Don't miss this outstanding release.

WAGNER
OVERTURE TO RIENZI
WOTAN'S FAREWELL
MAGIC FIRE MUSIC
OVERTURE TO FLYING DUTCHMAN
DIE MEISTERSINGER (excerpts)
Detroit Symphony Orchestra conducted by Paul Paray. Mercury SR90232. Price $5.95.

It has been noted previously that Frenchman Paul Paray has a peculiar affinity for the music of Wagner. His performances can't be called "Germanic" in the truest sense and yet his concept of the scores is as revealing and articulate as one could expect from his Teutonic contemporaries. Very possibly it is this Frenchman's innate love of drama that enables him to communicate so successfully the deeper meanings of these essentially dramatic works.

The sound is up to *Mercury's* usual high standards, with fine directivity, good phantom-center fill, and good depth perspective. The range of dynamics is tremendous and on a big stereo system, the room will really rock. All is bright and clean, with my only quibble that I thought the percussion, especially the tymps, were a shade muddy at times and could have benefitted from better articulation. Top piece here is the rarely played, but nonetheless exciting, "Overture" to Rienzi.

OPERATIC CHORUSES
Robert Shaw Chorale conducted by Robert Shaw with RCA Victor Orchestra. Victor LSC2416. Price $5.98.

This disc is a real sleeper! If you are an opera fan, get set for a fine feast of some of the best operatic choral work this side of the Met. In fact, and without denigrating the fine efforts of the Met, few opera house choruses have such beauty of voices, such precision, and discipline. Of course Shaw has been at this a long time and he is justly famous for his work in this field. Here is a collection of most of the familiar choruses, from equally familiar operas. Thus we have "Les Voici" from Carmen, "Soldier's Chorus" from Gounod's Faust, the "Bridal Chorus" from Lohengrin, a really rousing "Anvil Chorus," and others from Nabucco, Otello, Rigoletto, Die Meistersinger, etc.

The voices are deployed between the speakers, spilling over slightly to left and right, with the orchestra almost surrounding them. The sound is just wonderful, big and bright both vocally and orchestrally, with all the stereo virtues very evident. The massive sound is well contained and given body by the excellently handled acoustics. And glory be . . . there was virtually no choral blasting or "fusion" even in the climaxes.

TAPE TOPICS

The big news this month in the world of tape was contained in last month's ELECTRONICS WORLD. Yessir, ye editor and technical ed. stole a march on me with the announcement of the new *four-channel* stereo tape. I had known a little about it, but had no idea its introduction was quite that imminent. Full details are in last month's issue. The big thing about this is, of course, that it is the first link in the chain which will lead to the eventual commercialization of true three-channel stereo.

The system described uses a 4th channel, mostly as a reverb channel and, as such, opens some fascinating new avenues of experiment. Actually the 4th channel was a cleverly thought-out utilization of current *four-track* head configuration. Instead of two pairs of tracks playing back stereo in opposite directions, the four tracks are used in the one forward direction, with each track a separate channel of information, feeding into four amplifiers and four speakers.

As mentioned in the article, a specially recorded four-channel recording will be available for test purposes. The important thing about this is that with comparatively little modification to both dubbers and playback machines, the existing libraries of three-channel stereo masters can be used as the basis for true three-channel commercial stereo tapes. There is no technical obstacle that would appear to be insurmountable. It also goes without saying that once the three-channel tapes get off the ground through this system, specially designed three-channel tape playback units will soon be forthcoming. And if the four-channel idea should prove worthwhile and feasible, this too can be accomplished by incorporating the proper heads and circuitry into the master tape machines. An exciting development to say the least and one that I shall watch very closely.

No news yet from the Los Angeles Show or the May Parts Show as to the fate of the *CBS/3M* tape cartridge. We're watching this very closely, as well, and will bring you all possible info as soon as anything breaks. As not too unexpected, four-track tape activity has slacked off within the last month and the imminence of summer. But a few new items have come along and here they are forthwith.

BEETHOVEN
SYMPHONY #5
CORIOLAN OVERTURE
Chicago Symphony Orchestra conducted by Fritz Reiner. Victor 4-track FTC2032. Price $8.95.

A look at the *Schwann* catalogue will readily attest to the fact that there is no scarcity of recordings of the Bee-

thoven 5th Symphony. Staring aghast at the multitudinous choice, one wonders why there should be any valid reason for still more and newer recordings of this work. I won't attempt to answer that complex question, but I will make the observation that a really good recording of this work always sells well, and that is reason enough for most companies.

When on rare occasions, such as with this new *Victor* recording, the product is not merely good but outstanding, this old warhorse can rack up some pretty impressive sales.

This may not be the ultimate in performance values, but it is close enough to satisfy many people and, when sound is considered, this version wins hands down. Reiner essays a very powerful and vigorous approach, with tempi somewhat faster than most. However, this may be justified for the overwhelming grandeur of the sonorities his great orchestra produces.

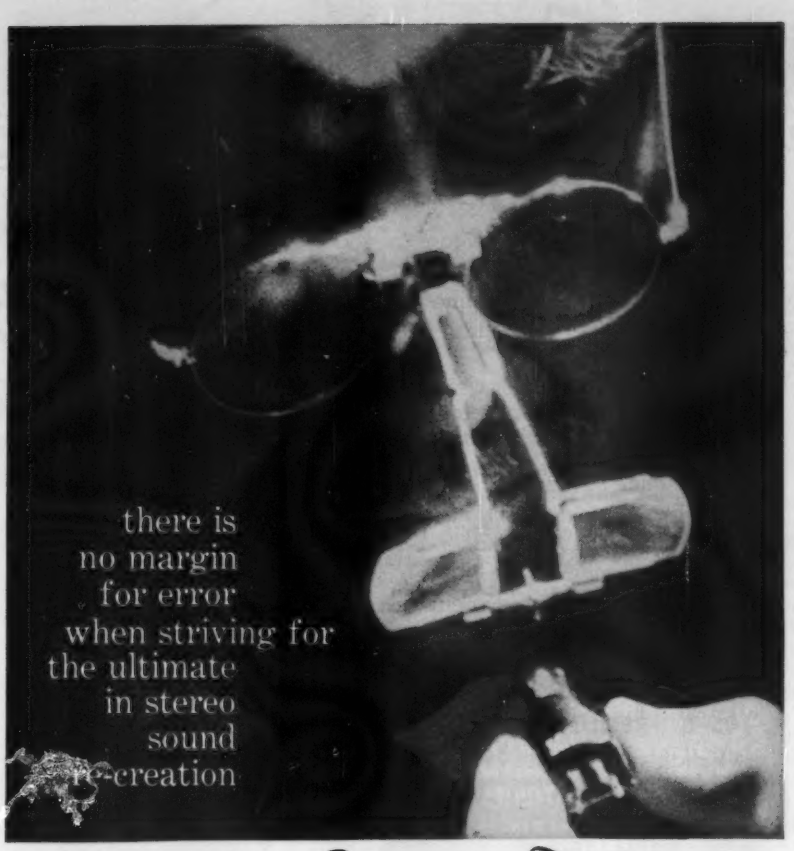
This is, without doubt, the biggest sounding of any existing version. The stereo is exemplary on all points... good direction and depth, full center fill, marvelous acoustic perspective. Except for a small smidgin' of overload distortion in the *tuttis* of the finale, and some occasional "print through," this tape is exceptionally clean. It is also nice to report that crosstalk was no problem and that even though the tape was played back at a good room-filling level, tape hiss was as minimal as I have ever encountered from a commercial tape. So there you have it... a fine performance, fabulous playing from the orchestra and great stereo sound... all adding up to the most desirable Beethoven 5th in the catalogue.

CHOPIN
PIANO CONCERTO #1
MENDELSSOHN
CAPRICCIO BRILLIANT
Gary Graffman, pianist, with Boston Symphony Orchestra conducted by Charles Munch, Victor 4-track FTC2050. Price $8.95.

Graffman continues to develop as one of our outstanding young pianists. His playing here is properly lightweight, with lovely tone spilling from his fingers with almost liquid dexterity. Yet this is not to say that his interpretation lacks vigor or conviction.

Munch furnishes a good accompaniment, not entirely sympathetic in certain matters of tempi, but in general respectful of the pianist. Soundwise, this is a nice clean recording, with the piano solidly emplaced in the phantom center. The piano is recorded a shade too close as also seems to be the orchestra, but oddly the result is not wiriness nor stridency but rather a sense of compression. This effect is probably heightened because the reverb content was on the short side and accentuated any feeling of "dryness."

Here, again, we have the not inconsiderable bonus of virtually inaudible crosstalk and exceptionally low tape hiss. The stereo was well done and direction is good except that for a large



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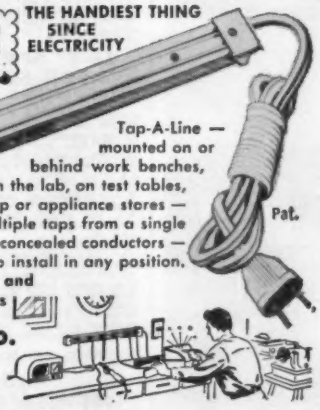

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16-5" Cletron speakers with 1 oz. magnet and 3.2 ohm V.C. Model 100. All 16 for $20.00.

Reprint of both Popular Electronics articles sent with each order.

Model AT-3 Horn Tweeter same as the Calrad CT-3, 8 ohm. McGees sale price $2.95, 2 for $17.00. Wire wound control and capacitor 98¢ per set.

Write for McGee's 1961 Summer Flyer

McGEE RADIO CO.
1901 McGee St., Kansas City 8, Missouri

part of the first movement of the Chopin, the piece appears too left-sided. This is not a technical fault but is a product of the scoring which just happens to produce that kind of result.

THE SOUND OF HOLLYWOOD
Medallion Strings directed by Emanuel Vardi, Kapp Medallion 4-track MST-47103. Price $7.95.

This is one of those collections of theme music from various hit motion pictures, and includes such things as the themes from the "Sundowners," "Never On Sunday," "Spellbound," "Sons and Lovers," "The Apartment," and seven others of similar lustre. The Medallion Strings is strictly a recording group, but it is composed of crackerjack men who play very well indeed.

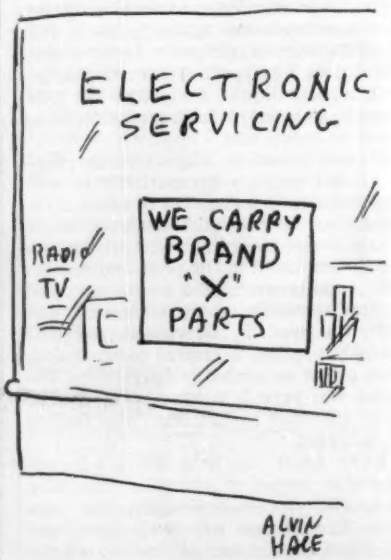
The recording is of the "super stereo" variety, featuring exaggerated directional effects and other distortions of the stereo perspective. As you might expect the strings are searing in their high register intensities and reverb is used with a liberal hand. However, all is nice and clean and of course this will sound good on the console stereo units and other lesser equipment.

JAZZ!
United Stereo Tapes Sampler Series. UST RQ403 4-track. Price $3.95.

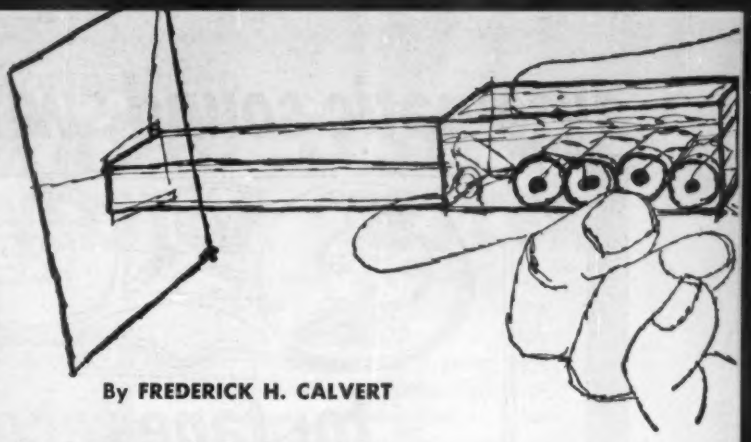
Here is another in the *UST* series of samplers, this time concerning itself with the jazz idiom. At $3.95 for almost a half an hour of music this is a darn good buy and a fine way to savor the delights of jazz on four-track tape, a repertoire which is very extensive.

The material ranges from the cool Dizzy Gillespie, through Count Basie and Gerry Mulligan, to traditionalist Wilbur de Paris, with other top jazz artists interspersed.

Sound for the most part is very clean, of the close-up type featuring great presence. Best cut is called "Trombones, Inc." a real rouser. Tape hiss very low here and a fine tape for transient testing. —30—



SIMPLE METAL LOCATOR



By FREDERICK H. CALVERT

A novel, 1-transistor circuit that will locate wiring and sheet-metal ducts in walls, floors, and ceilings.

WIRING and sheet-metal ducts in floors, walls, and ceilings can be easily traced with this simple instrument, when used with an existing standard broadcast receiver.

The simple beat-frequency principle is used in this instrument. The technique involves beating a fixed-frequency signal against a variable-frequency signal and noting the change in frequency of the beat note when the search coil is brought near metal.

In this system, the fixed-frequency signal is provided by tuning any BC receiver to a station on the low end of the dial. In the author's case, WIND (560 kc.) Chicago was used. This, of course, provides an extremely stable source of reference signal. The lower frequencies provide greater depth penetration and minimize capacitance effects. This unit will penetrate to a depth of from 4 inches to 10 inches depending on the size of the concealed metal.

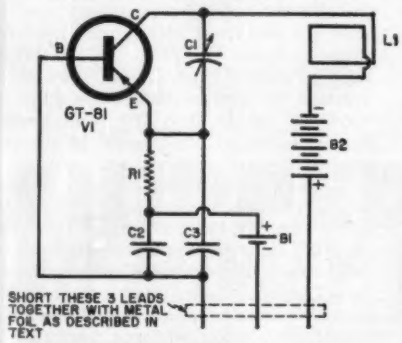
The variable-frequency signal is provided by a simple low-drift-type transistor oscillator whose tank coil is actually the search coil. Stabilization of the oscillator is obtained by putting as much resistance as possible in the emitter circuit and as little as possible in the base circuit. Bias for the base is supplied by one of the dry cells.

Amplification of the beat note is provided by the i.f. and audio system of the receiver with which the locator is used.

From the foregoing it can be seen that two-thirds of the circuitry normally required in a beat-frequency type of metal locator can be eliminated, *i.e.*, the reference oscillator and amplifier. Total cost of parts for this instrument should not exceed $3.00 and the dry cells will last several hundred hours in continuous operation since the total current drain is about 3-4 ma.

Maximum radiation distance of this unit is approximately 25 feet which is well within the limits established by the FCC. Optimum performance is obtained when the receiver and locator are no farther apart than five feet. A small transistor radio carried in the shirt pocket makes an excellent companion unit for use with this locator.

This simple transistor oscillator circuit beats against the received signal in a broadcast set. A change in the pitch of the beat note shows presence of metal.



R1—1000 ohm, ½ w. res.
C1—50-380 μμf. padder
C2—.01 μf. disc ceramic capacitor
C3—.001 μf. tubular capacitor
L1—50 t. #34 en. wound around 3" x 3" piece of polystyrene
B1—1.5-volt dry cell (Burgess Type NE or equiv.)
B2—Three 1.5-volt dry cells (Burgess Type NE or equiv.)
V1—"p-n-p" transistor (Type GT-81 or equivalent general-purpose audio or r.f. "p-n-p" type)

Construction

Construction is simple. First, wind 50 turns of #34 enamel-covered wire around the edges of a 3" x 3" piece of polystyrene, lacing it around the notched corners. Allow six inches of the ends to be free, twist together and scrape the enamel ¼-inch from the ends. Cover the winding with plastic cement and allow to dry.

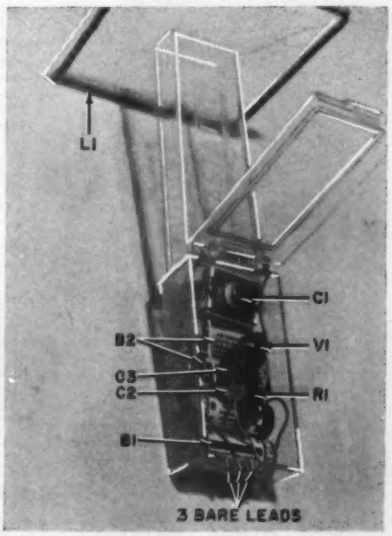
Pre-wire the oscillator and dry cells before mounting in the 1¼" x 2½" x ⅞" plastic box. Wrap plastic tape around the dry cells and place them in the bottom of the box. Place the padder capacitor at one end so it can be tuned when the cover is up, then glue in place with plastic cement. Transistor leads are cut to ½" and the .01-μf. and .001-μf. capacitors, along with the 1000-ohm resistor, are mounted directly on the transistor leads. Hold long-nose pliers on the leads at the point where they enter the transistor body to prevent damage during soldering.

Scrape ½-inch off the three leads at the latching end of the box and glue to the outside. After the glue dries, scrape these ends clean and free from glue. By placing a piece of metal foil over these three leads and closing the box cover on it, we have a simple switch for turning the unit on. After use, the metal foil is removed. The oscillator assembly is placed on top of the dry cells and the closed cover keeps it in place.

Under the hinged end, the two leads are brought out, trimmed to 1 inch, and soldered to the twisted pair from the search coil. Cement the cover from a plastic box of the type used to package phono cartridges (1" x ½" x 3¾") between the search coil and the oscillator box. Stranded wire, #26 plastic covered of the type found at hobby shops, was used in wiring the unit. Placement of parts and wiring is not critical.

With very little practice, it is possible to determine and outline the exact shape and location of the object you are seeking, thus saving a lot of futile plaster cracking and expense. -30-

The oscillator is built into a small plastic box. The search coil is wound on a three-inch square of polystyrene which is cemented to a plastic-box cover as shown in the photo below.



automatic sound switch for tape recorders

By FREDERICK H. CALVERT

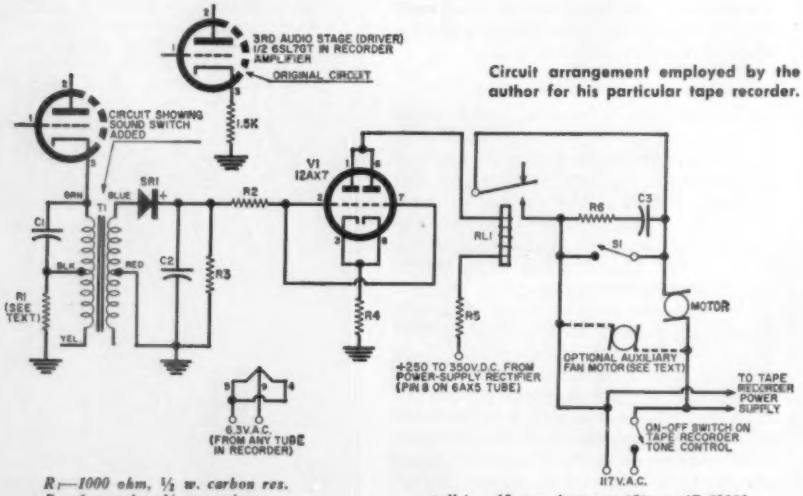
Add this audio-operated switch to your recorder to turn it on automatically when there is something to record.

INSTALLATION of this circuit in any tape recorder will prove a boon, especially to those who enjoy making "candid" recordings. It eliminates the otherwise constant running of the tape and the anxiety over whether or not something "recordable" will appear before the tape runs out.

This circuit allows tape to be consumed only when sound is present at the microphone, thus eliminating long, useless lengths of silent tape and much editing. Since it is extremely sensitive, it operates on very low sound levels throughout the entire range of the recorder volume control.

No major surgery is required and installation is confined to locating the cathode resistor in the third audio stage (or an equivalent portion of the record amplifier) and removing it. Hum and distortion problems are eliminated by obtaining the signal from the cathode circuit of one of the tubes in the recorder amplifier. The recorder's drive-motor leads must also be located, one of these must be cut and the ends extended to a switch to be added on the recorder panel. All components, except switch S_1, may be mounted on the tape-recorder chassis or on a small bracket or auxiliary chassis fastened to the side of the amplifier. (See schematic below.)

Connect the cathode to the input transformer, T_1, of the sound-switch circuit. The resistance of R_1 is approximately that of the original cathode resistor minus the d.c. resistance of the used portion of T_1 (350 ohms). If the original cathode resistor was bypassed, remove this capacitor. If removal of this capacitor adversely affects tape-recorder performance, then the audio signal required for the sound switch must be obtained elsewhere in the recording amplifier. Closing S_1 shunts the relay contacts and restores original recorder operation for playback or rewind.



Circuit arrangement employed by the author for his particular tape recorder.

R_1—1000 ohm, ½ w. carbon res.
R_2—1 megohm, ½ w. carbon res.
R_3—2 megohm, ½ w. carbon res.
R_4—10,000 ohm, ½ w. carbon res.
R_5—20,000 ohm, 1 w. carbon res.
R_6—510 ohm, ½ w. carbon res.
C_1—.05 μf., 200 v. capacitor
C_2—2 μf., 200 v. metallized paper capacitor
C_3—.1 μf., 400 v. capacitor
RL_1—Sensitive relay, 10,000 ohm coil, 1.4 ma. pull-in, .65 ma. drop-out (Sigma 4F-10000-SIL or equiv.)
SR_1—Silicon rectifier, 200 ma., 260 volts r.m.s. (Sarkes Tarzian Type 2F-4 or equiv.)
S_1—S.p.s.t. toggle switch, 3 amps @ 125 v. a.c.
T_1—Interstage trans., transistor type, 5000 ohms c.t.: 7500 ohms c.t. (Stancor TA-30 or equiv.)
V_1—12AX7 tube

Lead length of the wires connecting the sound switch to the amplifier is not critical but they should be kept as short as possible and be placed out of the way of the moving mechanical parts in the recorder.

For automatic sound-switch operation, the tape recorder is placed in "Record" position and S_1 is placed in its open position. When sound is present at the microphone, it is amplified by the tape recorder amplifier and fed from the third audio cathode to the primary of T_1. Capacitor C_1 filters out any amplifier background hiss and the a.c. component of the signal voltage is coupled through T_1 and rectified by SR_1. C_2 filters out the ripple and a positive d.c. voltage is applied to the grids of the 12AX7 tube through grid-current limiting resistor R_2.

Normally, the tube is biased by R_4 below the point where relay RL_1 will pull in. Upon receipt of sound at the microphone, the grids are driven positive, causing the tube to conduct full on. The contacts of RL_1 close instantly, energizing the motor and thus feeding tape through the recorder. When no sound is present at the microphone, the motor is kept running for an additional 4 seconds due to the time-constant of C_3 and R_3. This eliminates the need for restarting the motor after short pauses between sounds.

During an idle period, the voltage across the relay coil is about 2 volts d.c. and rises to 25 or 30 volts upon receipt of signal. The 12AX7 tube provides an amplification factor of 100 which contributes greatly to the sensitivity of the sound switch. Both triodes are wired in parallel to provide ample current for operating the relay that is used.

Plate and heater requirements are for 5 ma. at 250-300 volts d.c. and 6.3 volts a.c. at .3 amp. This is easily furnished by the existing power supply in any a.c.-operated tape recorder. Arc suppression of the relay contacts is provided by C_2 and R_6.

By adding the automatic sound switch, the tape recorder may also be used for dictation without the need for other switches and push-buttons. When used in this manner, it is desirable to actuate the system before speaking by blowing lightly into the microphone, thus eliminating any possibility of wowing as the motor starts up.

Most tape recorders will not require supplementary ventilation but, if desired, this can be provided by the addition of a few small screened holes or the installation of a small, quiet-running fan. The author's installation was made in a *Pentron* Model NL-1 and the additional ventilation was not needed.

Before adding the circuit to a recorder, place it in the "Record" position and allow it to run. Turn the recorder off and then on again. If the motor runs normally and feeds the tape through properly, the circuit may be added. If tape slack occurs when the recorder is stopped, adjust the supply-reel brake to prevent tape spillage or breakage. -30-

The Model 88....A New Combination
TRANSISTOR RADIO TESTER and DYNAMIC TRANSISTOR TESTER

The Model 88 is perhaps as important a development as was the invention of the transistor itself, for during the past 5 years, millions of transistor radios and other transistor operated devices have been imported and produced in this country with no *adequate* provision for servicing this ever increasing output.

The Model 88 was designed specifically to test all transistors, transistor radios, transistor recorders, and other transistor devices *under dynamic conditions.*

AS A TRANSISTOR RADIO TESTER

We feel sure all servicemen will agree that the instruments and methods previously employed for servicing conventional tube radios and TV have proven to be impractical and time consuming when used for transistor radio servicing. The Model 88 provides a *new simplified* rapid procedure — a technique developed *specifically* for transistor radios and other transistor devices.

An R.F. Signal source, modulated by an audio tone is injected into the transistor receiver from the antenna through the R.F. stage, past the mixer into the I.F. Amplifier and detector stages and on to the audio amplifier. This injected signal is then followed and traced through the receiver by means of a built-in High Gain Transistorized Signal Tracer until the cause of trouble whether it be a transistor, some other component or even a break in the printed circuit is located and pinpointed. The injected signal is heard on the front panel speaker as it is followed through the various stages. Provision has also been made on the front panel for plugging in a V.O.M. for quantitative measurement of signal strength.

The Signal Tracing section may also be used less the signal injector for listening to the "quality" of the broadcast signal in the various stages.

AS A TRANSISTOR TESTER

The Model 88 will test all transistors including NPN and PNP, silicon, germanium and the new gallium arsinide types, without referring to characteristic data sheets. The time-saving advantage of this technique is self-evident. A further benefit of this service is that it will enable you to test new transistors *as they are released!*

SPECIFICATIONS:

✔ Model 88 operates on a self-contained 4½ volt battery and is always ready for instant use on the bench or in the field.

✔ ***Signal Injector:***

The signal injector used in the Model 88 is a new departure in signal source design. Previously, signal sources were provided by signal generators operating on a single frequency and requiring retuning. The Signal Injector of the Model 88 employs a transistor in a grounded emitter self-modulating blocking oscillator generating a low R.F. frequency providing stable harmonics to 30 megacycles. A power output of over 2.5 volts peak to peak is provided. An attenuator prevents overload of the receiver or the amplifier under test.

✔ ***Signal Tracer:***

Two high-gain grounded emitter transistors are utilized in a high gain amplifier with sufficient output to operate the built-in 4½" Alnico V Speaker. A diode is used as a "clamp" to prevent overloading of the output stage. A volume control permits attenuation of strong signals. Provision is also made on the front panel for the addition of a meter or an oscilloscope for quantitative evaluation of the signal strength.

✔ ***Transistor Tester:***

The transistor tester used in the Model 88 measures the two most important transistor characteristics needed for transistor servicing; leakage and gain (beta).

The leakage test measures the collector-emitter current with the base connection open circuited. A range from 50 ohms to 100,000 ohms covers all the leakage values usually found in both high and low power transistor types.

The gain test (beta) translates the change in collector current divided by the base current. Inasmuch as the base current is held to a fixed value of 50 micoamperes, the collector current calibrated in relative gain (beta), is read directly on the meter scale.

The Model 88 will test *all* transistor types, including NPN or PNP, germanium, silicon, gallium arsenide and the newer diffused junction and mesa types.

Model 88 comes housed in a handsome portable case. Complete with a set of Clip-On Cables for Transistor Testing, an R.F. Diode Probe for R.F. and I.F. Tracing; an Audio Probe for Amplifier Tracing and a Signal Injector Cable. Complete—nothing else to buy!
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MOSS ELECTRONIC, INC.
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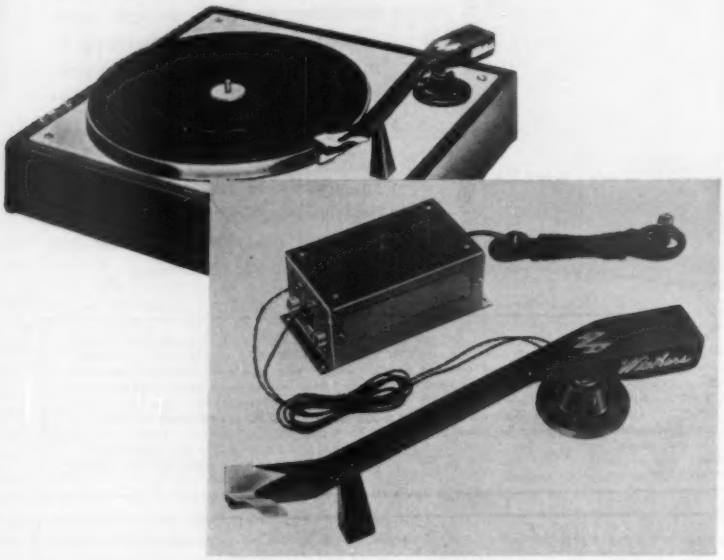
Product Test Report

LAB TESTED ELECTRONICS WORLD

Weathers K-803 Professional Stereo Pickup System
"Knight" KN-701 Reverberation Unit
Acrosound Stereo 120 Amplifier
Sencore "Transi-Master" Model TR110



Weathers K-803 Professional Stereo Pickup System

THIS stereo disc playback system, comprising a turntable, tonearm, cartridge, and phono preamp, is unusual in several respects. First, the turntable platter and drive motor achieve their fine performance because of their light weight rather than their massiveness. Second, the attractively styled viscous-damped tonearm is made of finely finished wood. Third, the cartridge is a special ceramic type that depends on slight changes in capacitance to produce signals rather than the usual piezoelectric effect. And fourth, the preamp, using what the manufacturer calls an "amplified bridge circuit" and polarizing supply, is transistorized, uses a modular construction, and is built right inside the turntable base.

We checked the stylus pressure first and found that it was set at just 1 gram, the value recommended by the manufacturer. When we switched the unit on, we found the turntable to be smooth-running and extremely quiet in operation. Frankly, we were a little apprehensive about the light aluminum platter and the small, lightweight synchronous drive-motor, but after putting the unit through its paces, all our fears were allayed. The single-speed turntable was rock-steady at 33⅓ rpm while tracking our test record, and the bars on our strobe disc looked as though the turntable wasn't even switched to the "on" position.

In order to see just how good the speed regulation was, we reduced the line voltage. We still couldn't get the bars on our strobe disc to budge, even with the voltage reduced to 40 volts. The 1000-cps tone from our test record was still pure 1000 cycles. Below 40 volts, the motor stalled and the turntable stopped. Then, we raised the line voltage to a value of 140 volts—at which the speed still remained absolutely constant. It would be pretty hard to beat this kind of speed regulation just as long as the line-voltage frequency remains at 60 cps. If the frequency of our power line varied, though, then the speed of the synchronous motor would also vary in direct proportion.

The *Weathers* drive-motor has a soft rubber drive wheel on it that bears against the turntable rim; no intermediate idlers are used in this ultra-simple drive system. Although this wheel remains engaged in the "off" position, it is so soft that it is extremely unlikely to take on a flat spot that would produce an audible "thump."

In listening to the output of our test record, we found absolutely no audible trace of flutter or rumble, even at very high listening levels. As a matter of fact we were able to hear a 100-cps test tone on one of our records that had been recorded at a level 50 db below the standard reference level. A scope connected to the output of the system disclosed the presence of a very low-level rumble signal, but this was mainly at a frequency of 10 cps. Both in level and in frequency, this is well below that reproducible from any speaker system. This unusually low rumble frequency occurs because the drive-motor operates at the relatively low speed of 600 rpm, or 10 revolutions per second.

The special ceramic cartridge is a plug-in type, and cable connections are made *via* a receptacle at the rear of the arm's slide track. The ½-mil diamond stylus is not replaceable by the user, but at 1-gram tracking force, it should last for several years.

The transistorized preamp and polarizing supply has two outputs per channel; one a high-level RIAA-equalized output and the other a low-level constant-velocity output for magnetic phono inputs. At a recorded velocity of 5 cm./sec. and a frequency of 1000 cps, we measured .55 volt from the high-level outputs and 8.5 mv. from the low-level outputs of both channels. Using the *RCA* 12-5-49 RIAA test record, the response was found to be extremely smooth and flat over the entire range, with a slight rise of only 2.5 db at 15 kc. Also, the outputs of both channels were within a fraction of a db of each other over just about the entire range.

Finally, we put aside our test records and connected the preamp to our hi-fi system to hear just what the system sounds like. Tracking at 1 gram, the pickup and preamp reproduced the most loudly recorded records we had on hand without a trace of audible shattering or breakup. Highs were silky and sweet, yet outstandingly detailed, and surface noise was unusually low. The system seemed to have no coloration of its own and, when playing a good disc, it produced sound that was best compared with that of the original master tape.

The K-803 is one of the best reproducers of stereo and monophonic records that we have tested to date. Although it is not inexpensive, the system provides superlative results. It is available complete with cartridge, tonearm, preamp, and single-speed turntable at $189.45. The price for all parts except the turntable is $129.50. —30—

"Knight" KN-701 Reverberation Unit

DESPITE outraged cries of "butchery" and "gimmickry" that greeted the current spate of reverberation devices for home use, artificial reverberation is a perfectly legitimate tool of the audio engineer's art. Practically every non-classical recording we listen to is liberally laced with artificial reverberation, produced acoustically in an echoic room with a loudspeaker and a microphone, or electronically *via* some kind of delay system.

Musicians and audio engineers agree that reverberation is an essential part

of musical sound, and recording engineers who know how to get just the right amount of the right kind of echo in a recording are scarce enough to be able to demand high salaries for their judgement. This, however, is at the crux of the criticisms aimed at reverb devices for home use.

The consensus is that a high-fidelity system should reproduce a disc with utmost fidelity, along with the reverberation that the recording engineer deemed best suited for the program material. But one man's artistic judgement may not suit another man's taste, which is why audio control centers are equipped with bass and treble controls. The fact that these can be misused, and often are, does not minimize their potential value, and the same holds true for a reverberation control. But to condemn any potentially useful device because it can be misused, or because its design has not

yet been perfected, is to discourage any further development in that particular direction.

The "Knight" KN-701 reverberation unit is designed around a delay device (using a pair of lightly stretched springs) which the *Hammond Organ Company* introduced for its electronic organs.* The unit is a stereophonic model, which is to say it has two separate signal channels. The signal to the reverb device is a mixture of both stereo channels, and the reverb signal is mixed equally back into the main signal channels. According to the instructions, the KN-701 requires connection in series with the main signal channels, at a point where the signal voltages are at a level of 0.1 to 1.0 volt. The tape output and input connections on a preamp with monitoring facilities are the most convenient insertion points in some systems, although a few control units deliver a low enough output voltage to their power amps to permit the KN-701 to be inserted between them.

The reverb unit has a gain of zero db. It has no volume control or input level-sets. Consequently, it is up to the equipment feeding it to provide the proper input signal level. If this is much over

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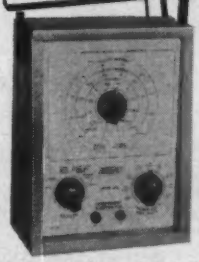

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0.5 volt, distortion will become rather severe. On the other hand, if it is appreciably below 0.1 volt, hum and microphonics may become troublesome.

With the reverb control fully off, IM distortion (60 and 6000 cps, 4:1) in one channel was measured at 0.32% at 0.1 volt r.m.s. output, 1.4% at 0.5 volt out, and 3.4% at 1 volt out.

Frequency response, still with the reverb control off, and at 0.5 volt out, was within ±1 db from 25 to 10,000 cps, and was down 3 db at 15 kc. Advancing the control to its 9 o'clock position caused the expected mild peaks and dips one normally associates with acoustical reverberation, but also caused a loss of about 6 db in level from 5 kc. up to beyond 15 kc. With the control at 11 o'clock a broad response rise of about 3 db appeared between 1 kc. and 4 kc.

Stereo separation, with the control off, measured 30 db at 1 kc., 23 db at 5 kc., and 25 db at 10 kc. in both channels. As the control was advanced, separation in the range around 2 kc. diminished progressively (as would normally happen in a reverberant room), although separation at 10 kc. never dropped below 10 db at any setting of the reverb control.

After this checkout, it is our conclusion that the addition of input level controls or a substantial increase in voltage-handling ability, plus more equalization of the reverb signal, would be worthwhile design innovations that would lift this device out of the interesting gadget class. However, in use, the KN-701 was quite effective in doing its prescribed job. It added a convincing aura of reverberation, in any controllable amount, with characteristics similar to what might be encountered in a room having extremely highly reflective wall surfaces.

The reverb unit's tube stages are in-circuit at all times, even when the reverb control is turned all the way down, so their distortion is added to that of the rest of the system. Actually with an average input signal of around 0.1 volt and the unit de-activated, distortion was so low as to be audibly undetectable when using the unit with a good-quality reproducing system. When using it with associated components whose distortion was extremely low, its presence was faintly detectable. However, hum and noise were completely inaudible.

All in all, we believe that this unit offers a good deal of potential as a highly interesting and musically worthwhile sonic-enhancement device. It is available from *Allied Radio* for $49.95.

-30-

*See "Reverberation in Principle & Practice" in our Jan. 1961 issue and "Reverbaphonic Sound System" in our Aug. 1960 issue.

Acrosound Stereo 120 Amplifier

ACROSOUND's newest addition to its line of hi-fi components is the Model 120 basic stereo power amplifier. This high-fidelity amplifier, rated at 60-watts continuous sine-wave power output per channel, is one that we would rate among the few very best designs available today. Power amplifiers, in general, are easy to build and in most cases no special test equipment is required to make final adjustments. This one is particularly easy to construct in that a printed-circuit board is supplied with most of the small components already mounted and soldered. Our total construction time was only about 6½ hours. A test voltage is available from the unit along with a meter that permits all balance and bias adjustments to be made without any difficulty.

Eight tubes are used—two 12AX7's, two 12AU7's, and four KT-77's—along with silicon and selenium diodes providing both "B+" and bias voltages. The circuit is an "Ultra-Linear II" design incorporating a special patented hybrid-feedback circuit.

Another feature that we believe important is the use of a "Surgister." This device, not usually employed in hi-fi amplifiers, permits all tubes to warm-up gradually before maximum voltages are applied. This results in a much longer tube life.

Following are the specifications we measured on one of the kits we assembled:

Sensitivity: 1.2 volts for 60-watts output.

Frequency response: at 2 watts, 3 to

30,000 cps, +0, −1 db; at 60 watts, 12 to 28,000 cps, +.2, −1 db.

Hum and noise: −74.3 db with reference to 2-watts output.

IM distortion (60 and 6000 cps, 4 to 1 ratio): .08% at 2-watts equivalent sine-wave output, increasing gradually to .24% at 60 watts. At 70-watts output the IM distortion was only .59%.

Harmonic distortion: at 60 watts, .72% at 30 cps, .40% at 1000 cps, and .47% at 15,000 cps. A value of 2% harmonic distortion was reached at 72.5 watts at 30 cps, and at slightly higher powers for other higher frequencies checked.

This power amplifier is thus seen to be conservatively rated. The manufacturer could just as well have called it a 70-watt-per-channel power amplifier, since even at this power level the distortion is below that detectable by the most critical listener. It is also interesting to note that most of the above measured specifications are somewhat better than those published by the manufacturer.

The channel separation was measured at 54.8 db (at 1000 cps), and the damping factor was slightly lower than the values indicated on the control. Our values were .36, .49, .61, 1.04, 1.5, 5.0, and 6.8 at the points designated as .5, .7, 1, 2, 4, 10, and "off," respectively.

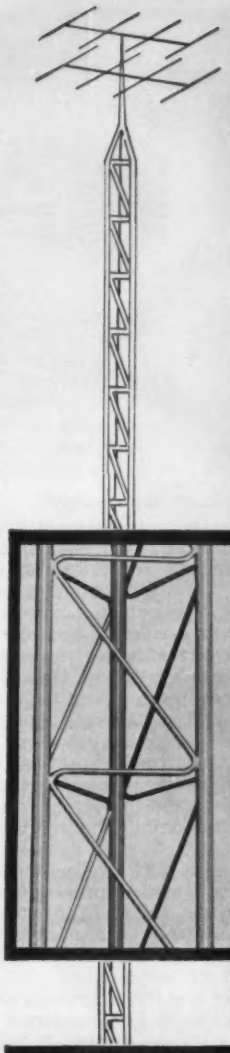
Since we actually built the amplifier kit, it is reasonable to expect that all other units should have the same quality performance as the one we tested. One point that must be mentioned is that all bias and a.c. balance adjustments were made to give us minimum distortion as indicated on our test equipment. In following the adjustment procedure recommended by the manufacturer, that is, using the test signal from the amplifier and the meter for setting both balance and bias adjustments, our distortion figures came out somewhat higher. However, all were within the 1% IM distortion and 2% harmonic distortion figures which we consider as reference standards.

Listening tests disclosed a clean audio quality and no undesirable "overhang." There was no listener fatigue even after several hours of hearing all types of recorded music. It is obvious that this amplifier is well designed and so constructed that it can operate hour after hour, even at full output power, without detrimental effects to the tubes or components. The Model 120, attractively styled in charcoal brown and beige, is available in either kit form at $159.50 or factory-wired at $219.50. —50—

Sencore "Transi-Master" TR110

THE MANY facilities combined in *Sencore's* "Transi-Master," Model TR110, are scarcely suggested by the tester's compactness and light weight. Assuring complete portability is its independence of external power: a pair of self-contained 1.5-volt "C" cells make this possible.

The technique used in working on radios or other equipment using tran-



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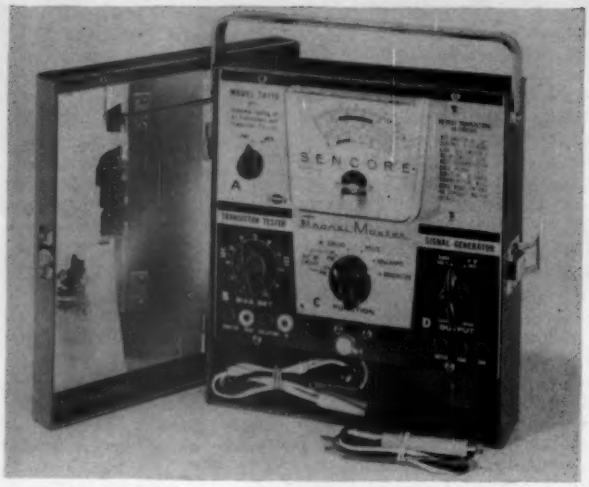


sistors is generally quite different from the method applied to tube-using devices, where tubes are likely to be checked first. Before transistors are tested directly, there is an extensive test sequence, as a rule, on the equipment itself. The fact that transistors tend to be wired directly into their circuits is just one reason for this. *Sencore's* designers have taken this into account. Thus the "Transi-Master" is a self-contained instrument that can be used to check batteries, measure current drain, localize trouble by signal injection, provide an in-circuit check of transistors and finally—in case a short in the circuit gives a false reading on the in-circuit check—provide an out-of-circuit test. The unit functions as a milliammeter, voltmeter, diode checker, and signal generator with a.f. or modulated i.f. and r.f. output.

The in-circuit check is a dynamic one, in which the transistor is connected to an integral oscillator circuit. A transistor that is defective will not sustain oscillation. Out-of-circuit tests include d.c. gain read on a scale calibrated directly in *beta*, leakage, opens, and shorts. Use of the milliammeter (50 ma., full-scale) to check total drain of a transistorized radio is facilitated by test leads terminating in a specially designed clip. Simply slipping the latter between one terminal of the battery or battery string and its connecting contact in the receiver places the milliammeter in series with the power supply.

The voltmeter (12 volts d.c., full-scale) facilitates battery checks, with and without load, and can be used to take some circuit readings. (Input resistance is only 4000 ohms.) The transistorized generator provides a 2000-cps sine wave for injection into audio stages, in one position. Throwing a switch converts it to a saw-tooth generator with the same fundamental frequency. Output is thus a long chain of closely spaced higher harmonics (only 2000 cycles apart) that may be said, in effect, to be modulated by the fundamental. When this signal is injected into any tuned r.f. or i.f. circuit, the latter selects the nearest harmonics, passes them on with amplification if the circuit is operating properly, and permits the modulation to be detected and reproduced in the radio's speaker as an audible indication. A generator of this type obviously requires no tuning or other adjustment.

The versatile "Transi-Master" has some auxiliary functions, including its ability to assist in determining some of the characteristics of an unknown transistor type. The inner surface of the removable, hinged cover is mirrored, so that both sides of a printed radio board placed on it can be viewed simultaneously, for circuit tracing. A compartment holds the assortment of special leads and the test set-up chart, in booklet form. The latter, which lists foreign as well as domestic types, is kept up-to-date at a nominal charge by signing and mailing in the registration card.

Concerning features and performance, one may ask whether the instrument does enough—or perhaps too much. To evaluate this, we must consider certain peculiarities of transistors. It is much easier to evaluate a tube's probable performance on the basis of a check in a tester than is the case with a transistor—and yet there are no totally infallible tube checkers. The poorer correlation between measurable characteristics in a transistor and potential performance poses something of a problem. In the TR110, the chance of reaching a wrong conclusion is narrowed down by the multiplicity of tests. In many cases, a clear-cut basis for rejection will be obtained quickly; when this doesn't happen, the user can fall back on the additional ammunition.

The user's judgment will also play a considerable role in the ultimate usefulness of the instrument. The sequence in which he uses the available facilities, which may vary with the particular problem he is troubleshooting, will be an important factor. For instance, he may decide that a check of the battery current drain, and then the circuit should precede any evaluation of transistors. Whatever logic is dictated by the situation, he should be able to handle the majority of jobs without going beyond this all-around tester.

Net price of the "Transi-Master" is $49.50. —30—

High-Z V.F.O.

(*Continued from page 60*)

author's variable-frequency oscillator.

Short-circuiting the v.f.o. output changes its frequency about 500 cycles, but transmitter adjustments have little effect when working "straight-through," and none at all when doubling frequency.

Keying is practically chirpless; that is, no chirp is detectable unless the frequency is multiplied up to as high as 28 mc., where a trace (not enough to be objectionable) shows up. This compares favorably with a *good* crystal oscillator.

Frequency drift is practically nonexistent. Five minutes after it has been turned on from a cold start, the v.f.o. can be zeroed in on a zero-drift crystal that has been thoroughly warmed up and it will hold zero beat within five or ten cycles for hours.

Changing the a.c. line input from 100 to 130 volts causes frequency to drop a total of 160 cycles, or 5.33 cycles per line-volt change. On a normally stable a.c. line, no voltage regulator is needed, unless very-high-frequency c.w. operation is to be a specialty.

Solid construction makes the unit immune to modulation from any normal banging around on the operating desk. In fact, the stability of the v.f.o. shows up the author's receiver pretty badly and suggests that it might not be a bad idea to build a new one. There is no reason why the high-Z oscillator in a superhet should not make a receiver just as stable as the transmitter. Meanwhile, if you can use a better transmitter frequency control, build this high-Z v.f.o. -30-

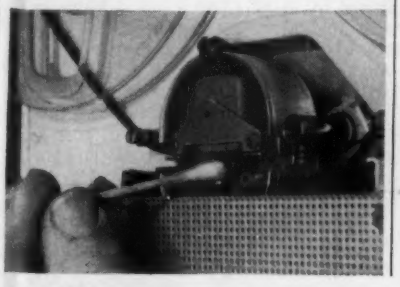
TAPE RECORDER HINT

By GLEN F. STILLWELL

A FREQUENT, but not always obvious, cause of tape recorder failure is simply a dirty recording head. A film of dirt or oil collects on the head and reproducing efficiency drops and distortion results.

In most cases, this trouble can be overcome almost instantly by saturating a cotton-tipped quill ("Q-Tips") in alcohol. This can then be used to clean the head. Used in the hard-to-get-at places around the head, the swab can also be used to pick up any foreign substance which might interfere with satisfactory reproduction.

Extra long, double-headed swabs are now readily available and should be a part of every tape-recorder service kit. -30-



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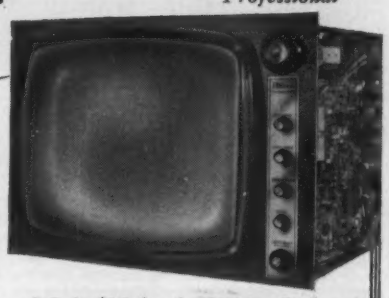

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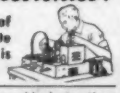

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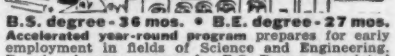

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SERVICE INDUSTRY NEWS

COLOR TV won't surrender the limelight. On the heels of developments noted in this space last month, *General Electric* announced its re-entry into the receiver market. A choice of color models will be on sale this fall, actually in August. The sets are scheduled to be in the distribution pipelines as you read this. They will feature a patented color-balance stabilizing circuit designed to counteract a common performance problem. The balance of hues in a color set is sometimes upset when the picture brightness level changes. The circuit provides automatic correction.

With a majority of the nation's leading TV manufacturers now in the color camp and at least two more strongly rumored to be considering coming in, the announcement is significant. Also noteworthy is the fact that *G-E*, like *Zenith* (see last month's column), is offering something special in the way of circuitry. In recent years, color receiver design has tended to stabilize at a point generally considered to be very satisfactory. With competitive advantage as the spur, a new round of design improvement seems to be in the making. Still better sets, if not less expensive ones, should be on the way.

Another significant point has to do with service. *G-E* plans no radical changes in present arrangements. To insure good color service, the manufacturer is launching the "D-O-T" (Diagnosis Over Telephone) plan. Every service technician in the country, independent or otherwise, will be able to call on local, factory-trained color experts for immediate consultation. *G-E* attributes its new move to the fact that "color TV is now entering the initial phase of mass-market acceptance which, eventually, will put it in a major position in the TV market."

Other unofficial stories have it that at least one important manufacturer of picture tubes other than *RCA* is thinking about producing the three-gun CRT's in quantity. Taken together, recent developments bespeak a widespread feeling throughout the industry that color TV will finally be in orbit before the year is out.

Tax Refunds and Profits

The Bureau of Internal Revenue is now in the process of distributing a $5-billion tax-refund melon to tens of millions of taxpayers. The average payment is $140. "TESA News," published by TESA of Wisconsin, alertly points out that this distribution has a strong business potential for service shops.

If you don't see the connection, think back to some of the service jobs you didn't get over the past few months. How many times have you had a customer hold off on a picture-tube replacement or costly overhaul for want of funds? Now is the time to put in your bid for a cut of your customers' refund windfalls. Get on the phone and promote those delayed jobs now, or send out promotion pieces pegged to the tax-rebate theme.

While we're on the subject of income taxes, we'd be interested in seeing how *Raytheon's* Comprehensive Management Plan, available to its bonded dealers, has worked out. A well-known tax-consultation and business-service organization works with the participating shop owner on his records, providing money-saving assistance in record-keeping and other business matters. Based on the premise that seven people out of ten overpay on their income taxes, the plan also promises to effect legitimate savings in this area with its expert help in the preparation of returns. It also makes this confident offer: guaranteed payment of any fines or penalties that result from any errors it may make.

Are You Hurting Yourself?

The service dealer often has good cause to pin the blame for certain of his difficulties on distributors, manufacturers, customers, and others. For his own sake, however, he ought to make sure that he isn't simply finding convenient scapegoats for his own failings. Jim Hornaday, editor of "The Printed Circuit" (North Carolina Federation of Electronic Associations), puts his finger on a weakness of this kind.

"We have hopped on some of our area distributors," says Hornaday, "for selling Citizens Band equipment, parts, etc., direct to what I feel should be our customers. After discussing the matter here and there, I begin to feel that I might have been a bit unfair. After all, if we won't even make a mild effort to take care of this trade, somebody is going to. And, from what I have been able to find out, the tremendous majority of the shops are refusing to have anything to do with CB equipment in any form—which is a sad mistake. If you are going to insist that these people buy from your distributor in this line, how can you blame that distributor if he sells these people anything they want?"

Growth in the electronic service market, as in other fields, is dependent on change. Any shop owner who refuses to

keep pace with new opportunities has only himself to blame for his destiny.

RCA Dealer Plan—Again

In March, we reported a "new" plan worked out between the Indianapolis TV Technicians Association and the *RCA Service Co.* It called for de-emphasis of factory service in Yellow-Pages advertising in favor of independents. W. C. Pecht of TEAM, St. Louis (May column), pointed out that there was nothing new in the plan, with similar arrangements already existing in his area and others. Now Frank Teskey of Indianapolis, editor of the "Hoosier Test Probe," wants us to know that the agreement achieved in his city is indeed distinctive.

In the past, Frank reports, *RCA* listings under Television Service have been headed with a prominent entry on behalf of the service company. Independents have been listed alphabetically in regular type under this special material. From now on, the service company's listing will take its place down the list, in regular type, alphabetically with the other "R's." Thus the entry will not give any implication to the service seeker that the manufacturer's service company is better than an independent.

Frank insists that this has never happened before. The important thing is not whether his claim is absolutely correct or not, but that ITTA deserves credit for a significant achievement in any case. So, if any reader can unearth evidence to dispute this "first"—we'd rather not hear about it. We're beginning to feel like a ping-pong ball.

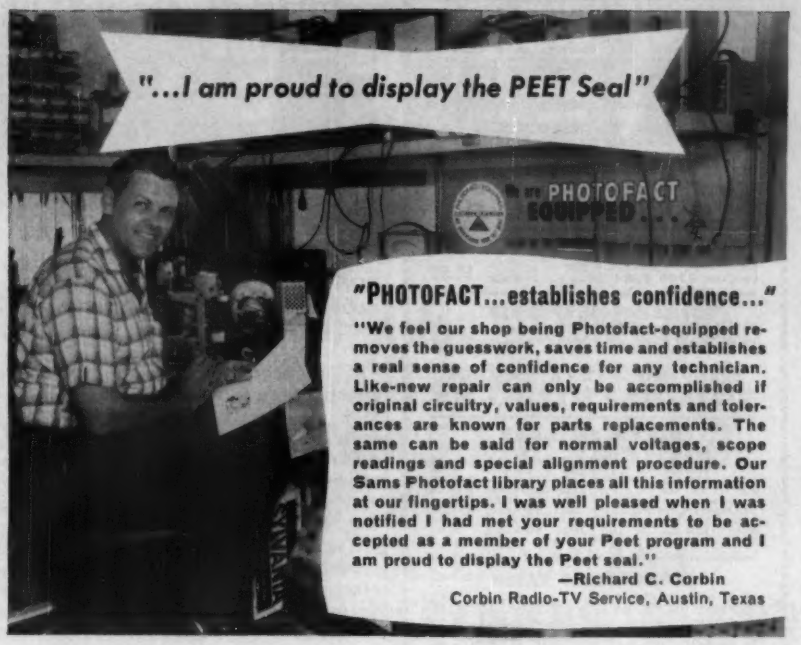
Special Product Service

Television Service Association of Detroit, Mich., has taken a sensible step to enable members to help themselves and each other when they are confronted with the service of products that are off the beaten track, especially those still in warranty. It has published in "TSA News" a list of member shops that have factory authorization or specialize in a wide range of products and manufacturers. Included are such products as tuners, tape recorders, garage-door openers, record changers, antenna rotators, auto radios, air conditioners, electronic organs, closed-circuit TV, and others.

Elsewhere Harold Chase, editor of "TSA News," reports an unhappy fact. He estimates that do-it-yourself tube checkers in non-service installations are now taking away more than 50 per-cent of the independent's tube sales in his area. Less than a couple of years ago, the figure was about 33 per-cent, which is bad enough.

Stamp for Service?

NATESA is pressing the Postmaster General to authorize a special stamp commemorating the contributions of the service industry. The proposal is scheduled to go before a Stamp Advisory Committee. Frank Moch, NATESA executive director, urges a letter writing campaign to the Postmaster General to push the proposal. -30-



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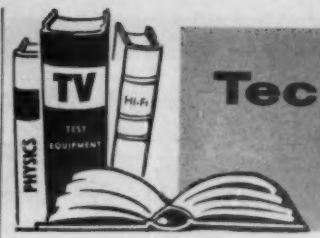

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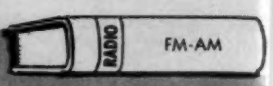

"INTERNATIONAL TRANSISTOR SUBSTITUTION GUIDEBOOK" by K. A. Pullen, Jr. Published by *John F. Rider Publisher, Inc.*, New York. 64 pages. Price $1.50. Soft cover.

This handbook lists over 4500 direct substitutions for transistors made in the U.S., Japan, Britain, Holland, France, Italy, and Germany. Communication, industrial, and computer types are covered and consideration has been given to case style and sizes when recommending the replacement.

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"LEARNING MORSE" by H. F. Smith. Published for "Wireless World" by *Iliffe Books Ltd.*, Dorset House, Stamford St., London SE1. 20 pages. Price 25 cents postage prepaid. Soft cover.

This is the Thirteenth Edition of a popular guide to "wireless" operating written by the former editor of "Wireless World." The booklet gives methods of learning the code, operating the key, and methods of practice. There are also details and descriptions of equipment and plans for an easy-to-build transistorized practice set.

The text includes the International Morse Code in full as well as the revised "Q" code, adopted in 1959 and effective this year. Finally, a series of practice and rhythmic groups complete the book.

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"FOUNDATION FOR ELECTRIC NETWORK THEORY" by Myril B. Reed. Published by *Prentice-Hall, Inc.*, Englewood Cliffs, N.J. 349 pages. Price $13.00.

This is a unique approach to network theory, eschewing calculus in favor of algebra. The author contends that such a system permits the merger of a.c. and d.c. theories without distinction. Although based on a course being offered graduate students, the book is also suitable for a rigorous course at a lower level.

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The text includes an up-to-date treatment of coding theory that emphasizes those formulations and mathematical techniques that have proved to be of greatest engineering significance.

Although designed especially for engineers in the communications field, it can be used by those in other areas of the communication sciences as well as by graduate students working toward an E.E.

* * *

"MUSIC DICTIONARY" compiled and published by *Ottenheimer Publishers, Inc.*, Baltimore, Md. 186 pages. Price $1.00.

This compact, vest-pocket "dictionary" lists nearly 5000 musical terms ranging from "A" the note to "Z" for zymber—a cymbal. The book is marginally indexed to enable the listener to locate the definition even while Maestro Bernstein is elaborating the point on the TV screen.

* * *

"AUTO RADIO MANUAL" compiled by Sams Staff. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 160 pages. Price $2.95. Soft cover. Vol. 12.

This newest volume in the auto radio series of manuals covers 63 models produced during 1959-60, including the following brands of sets: *American Motors, Automatic, Buick, Cadillac, Chevrolet, Edsel, Ford, Lincoln, Mercury, Monitoradio, Mopar, Motorola, Oldsmobile, Pontiac, Riverside*, and *Studebaker*.

Like its predecessor volumes, each set is treated to a complete rundown including schematics, resistance charts, chassis photos, parts lists and replacement data, alignment information, push-button adjustments, as well as other hints for servicing the sets efficiently.

* * *

"TRANSISTOR SUBSTITUTION HANDBOOK" compiled by Sams Staff. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 96 pages. Price $1.50. Soft cover.

This book is designed to minimize the problem of selecting suitable transistor replacements by (1) specifying the manufacturer from whom each of over 2700 transistor types is available and (2) indicating whether the unit is *n-p-n* or *p-n-p*.

The handbook lists over 6500 direct transistor substitutions, including a separate section which shows 668 suitable replacements for Japanese units. Also included is a separate directory of semiconductor diodes and rectifiers, with recommended substitutes.

The text sections explain why transistor substitution is possible, when it is

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1S5	6AH6	6C4	6V6	12AZ7	26
1T4	6AK5	6C5	6W4GT	12B4	35A5
1U4	6AL5	6C6	6W6GT	12BA6	35B5
1U5	6AL7	6CD6	6X4	12BA7	35C5
1V2	6AM6	6CD6G	6X5	12BE6	35L6GT
1X2	6AN8	6CF6	6X8	12BF6	35W4
2A3	6AQ5	6CS7	6Y6G	12BH7	35Y4
2AF4	6AQ6	6CL6	7A4/XXL	12BQ6	35Z5GT
2C26	6AQ7GT	6CM6	7A5	12BR7	37
2C34	6AR5	6CM7	7A6	12BY7	38/44
2E26	6AS5	6CN7	7A7	12CA5	42
2C36	6AT6	6CS6	7A8	12J5	43
2CP6	6AT8	6CU6	7B4	12K7	45
2C51	6AU4GT	6DE6	7B5	12L8	50A5
3LF4	6AU6GT	6DQ6	7B6	12Q7	50B5
3Q4	6AU8	6F6	7B7	12SA7	50C5
3S4	6AU9	6H6	7B8	12SG7	50L6GT
3V4	6AV6GT	6J4	7C5	12SJ7	80K6
4BQ7A	6AV6	6J5	7C6	12SK7	84
4B32	6AW8	6J7	7C6	12SN7GT	57
5AB4	6AX4GT	6K6GT	7C7	12SQ7	58
5AT8	6AX5GT	6K7	7E6	12V6GT	71A
5AV8	6B8	6K8	7E7	12W6GT	75
5AW4	6BA6	6L7	7F7	12X4	76
5BK7	6BC5	6N7	7F8	12Z3	77
5J6	6BC8	6Q7	7H7	14A7/12BY7	78
5T8	6BD6	6S4	7N7	14B8	80
5U4G	6BE6	6S8GT	7Q7	14Q7	84/6Z4
5U8	6BF5	6SA7	7X7/XXFM	19	117Z3
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appropriate, how to choose substitutes, and precautions to be taken when substituting.

* * *

"INDUSTRIAL ELECTRONICS" by Paul B. Zbar. Published by *McGraw-Hill Book Co., Inc.* under the sponsorship of the EIA and New York Trade School. 201 pages. Price $5.00.

This is another of the laboratory manuals being sponsored by the EIA in connection with its technician training program at the New York Trade School. Like the previous volumes covering basic electricity, basic electronics, basic radio receiver and television servicing, and advanced TV servicing techniques, this volume is divided into 39 "jobs"—each project consisting of an outline of objectives, a listing of materials and test equipment required to do the job, theory and basic principles involved in the job, detailed step-by-step procedures for performing the experiment, then a series of test questions to codify the conclusions reached in the text.

The lavish use of schematics, waveforms, charts, and tables will make this lab manual useful to the industrial electronics technician as a reference guide even after the course for which it was designed is concluded.

* * *

"HOW TO REPAIR SMALL APPLIANCES" by Jack Darr. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 128 pages. Price $2.50. Soft cover.

Handling small appliance work is a natural for radio-TV service shops, especially those located in or near residential neighborhoods. The author, a practicing technician himself, suggests that there are extra dollars to be earned by handling toasters, shavers, irons, electric blankets, knife sharpeners, mixers, coffee makers, electric skillets, fans, heating pads, sewing machine foot controls and the like. Practically no additional equipment and few replacement parts are required to handle such work and the knowledge needed to tackle the job is easily acquired—by means of this book, for instance.

* * *

"ABC'S OF COMPUTERS" by Allan Lytel. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 128 pages. Price $1.95. Soft cover.

Computers have captured the imagination of the public to such an extent that there was a real need for a basic, self-teaching introduction to their mysteries. The text is presented in simple, easy-to-understand language and tells what computers are, how they operate, and what they can be expected to do—now and in the future.

Both digital and analogue computers are covered along with explanations of numbers for computers, arithmetic operation, octal numbering, numbering codes, symbolic logic, and basic logical circuits. The text is lavishly illustrated with photos, line diagrams, charts, partial schematics, etc. to make the subject doubly clear to the reader.

This volume is suitable as an elementary classroom text or for home study. —30—

1 Compactron, 3 Circuits

(*Continued from page 43*)

ing pulse is applied to the plate from the horizontal-output system through a .001-μf. capacitor. Video-signal input is taken from the plate circuit of the video amplifier and applied to the a.g.c. grid through a 150,000-ohm resistor. Presence of the latter establishes a time constant, in conjunction with other circuit values, that prevents brief pulses from affecting the a.g.c. output. But for this, unwanted noise might change the a.g.c. output voltage briefly. Since the latter is used as part of the biasing arrangement for the noise inverter, such short-term changes could work to reduce the inverter's effectiveness. As is customary, a.g.c. output is at two voltage levels: one for the video i.f. system and another for the front end.

Since *Admiral* reports no other compactrons scheduled for immediate use in its sets, the 6K11 will stand alone in one small corner of its chassis (Fig. 2), surveying the greater number of standard tubes that will keep it company. It will have a one-piece heater that runs through the cathode sleeves of all three triode sections, but whose special construction uses only two welds to promote long life and reliable operation. The short-mount construction reduces the chance of bowed cathodes and grid-to-cathode shorts. The manner of bringing out pin connections through the base simplifies the problems of internal construction and support, as with most compactrons. This particular unit also features a shield between sections 1 and 3 for electrical isolation and avoids the sharing of base-pin connections by more than one electrode. Every element in each section is brought out separately, but there are only two pins for the entire, continuous heater. A low-microphonic, low-leakage mica design is used. Seated height of the 6K11 is only 1⅜ inches—less, for example, than that of a 12AU7 or one of many other, popular twin triodes.

Current reports indicate that the 6K11 will soon be followed by relatives, in equipment made by *G-E* as well as other equipment manufacturers. Compactrons are being registered with the EIA and put into production when it becomes evident that they are going to be used. Now registered and being made are five units in addition to the 6K11: the 6FJ7, whose shell encloses two, dissimilar triode sections; the 6C10 and the 6D10, two more triple triodes; the 6B10, which includes a duplex diode and two triodes; and the 6AX3, a single diode. The latter appears to be intended for damper service.

At the initial announcement, *G-E* used a tiny, two-compactron table radio to dramatize the development and demonstrate its practicability. Oddly enough, there is no clear evidence yet that a commercial version of this radio is on the way. Types in production suggest that compactrons are primarily making headway in TV receivers. —30—

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The frequency response of every AR speaker is checked in an anechoic chamber before it is shipped. (Many other tests, of course, are also made.) Acoustic Research is one of the very few companies in the history of loudspeaker manufacturing, so far as we know, that have followed this rigorous practice.

Silvano Cannavacciuolo, AR inspector, checks a speaker response curve at one of AR's anechoic chambers. The response curves of the individual drivers in the system he is testing have already been recorded and found acceptable at the main anechoic chamber.

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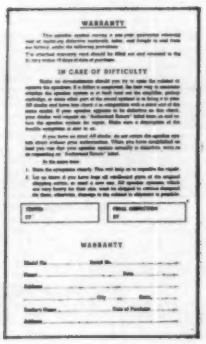

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Mac's Service Shop

(*Continued from page* 38)

"Which, I take it, means: Don't sing the blues; know your electronics theory thoroughly; keep abreast of new developments in the field," Barney again translated.

"That's the idea. Our trade magazines do their level best to keep us aware of the many opportunities opening up in maintaining industrial electronic equipment. It behooves all of us to get a foothold there while we still carry on our broadcast radio and TV servicing work. Mobile communications services are increasing tremendously, and taking care of this equipment is another string we should add to our bow. And there is closed-circuit TV, and—"

"I get the idea," Barney interrupted. "You don't need to knock me down with it. But do you think radio and TV servicing as we know it, is likely to fold in the near future?"

"Fold, no; change, yes," Mac said tersely. Just think of the changes that have taken place since you started to work for me: TV grew from a novelty to the major portion of our work. Color TV came in. So did transistor receivers and printed circuits. In these comparatively rapid changes is contained a reason why I doubt automation will take over entirely in the radio and TV industry in the immediate future. Automation, to be economically practical, needs to work on a product that is comparatively stable in design. If the whole automatic production line has to be entirely revamped every little while to incorporate important improvements or simply to change models, this quickly becomes time and money consuming. As long as customers insist on a wide variety of models from which to choose and as long as manufacturers compete to please them, radio and TV sets are not likely to be entirely produced in automatic factories. Until they are, the service technician will probably not be reduced to a mere module changer.

"But I've been saving the really bright side of the picture for last," Mac continued. "If you think a bit, you realize automation is working *for* the electronic technician, not *against* him. Electronics is the very heart of automation. The machines do their work, report on their progress, check their output, and examine themselves all by means of electronics. Electronic engineers play a big part in designing the equipment and electronic technicians install, adjust, and maintain it. The electronic technician will be the fair-haired boy in the automatic factory. But you are awfully quiet, Matilda. What do you think of all this?" Mac broke off.

"I've been too busy taking notes to do much thinking," Matilda said as she glanced over the shorthand notes she had been scribbling on the back of a job-ticket. "You know you're supposed to give a talk at the next meeting of the local technicians organization, and I thought this might make a good subject. Let's see if I've got you straight:

"You think automation is going to make a tremendous difference in all our lives in the near future, and you believe each of us should be thinking about what this will mean to him personally. Already many jobs are disappearing in various fields as automation takes over, and it is just starting. While automation yet is chiefly confined to manufacturing, it still has far-reaching effects in other fields, such as maintenance. Conceivably, automation of radio and TV factories could reduce the service technician to a mere module-changer, but you do not expect that to happen for some time. All the same, you think it's only prudent for the service technician to improve his general knowledge of electronics and to diversify his work and interest by taking on the servicing of industrial electronic equipment, mobile radio equipment, etc. His trade magazines are doing their best to help him in this respect if he will only study the articles they publish that are not directly connected with repairing household radio and TV receivers.

"Taking the long view, you believe the well-trained, alert, progressive technician who does not insist on doing just radio and TV service will be benefited rather than hurt by the rise of automation. This is true because electronics is the heart of automation, and it will not work without the services of the electronic technician."

"Did I say all that?" Mac marveled. "I'm growing old and garrulous, I reckon. But thanks for taking the notes. A machine would never have thought of doing that. Come on, Buster; let's put away the crystal ball and turn out some of these commonplace radio and TV sets. They're still our bread and butter and probably will be for quite a while." —30—

CB ROUND-UP SET

TRI-STATE Radio Club of Rossville, Georgia has announced its First Annual CB Round-Up Jubilee to be held July 2-3 at Fort Mountain, 3 miles east of Chatsworth, Ga. on U.S. Highway 411.

Besides a wide variety of outdoor sports activities (including hiking, archery, skeet, target, swimming, fishing, etc) the organizers have planned a program of hi-fi, mountain music, and square dancing.

Prizes will be awarded for the most distant CB unit attending and other features. Favors will be given to children.

Those planning to attend should get in touch with Charles A. Agan, 6W5984, 1216 McCallie Ave., Chattanooga, Tenn.

CB LICENSE NOTICE

THE FCC reminds all applicants for class D stations in CB service that under Item 9 on the form they are to be sure to state the kind of business and/or personal activities in which the radio facilities are proposed to be used, as well as the manner and purpose of such use.

As examples, the FCC listed:

"In the operation of my real estate and restaurant business, for communication between my home, my car, my place of business, and my employees."

"For personal communications between my boat, my car, my residence, and my summer camp." —30—

Within the Industry

(*Continued from page 24*)

plant in Fort Lauderdale, Florida. Headquarters and main plant of the firm are at Stamford, Conn. . . . **OLYMPIC RADIO & TELEVISION DIV.** has moved into an intensively mechanized plant in Glendale, Long Island. The 200,000-square-foot facility will employ approximately 800 people when operating full capacity as well as enabling the company to consolidate its warehousing and shipping operations.

* * *

MURRAY SPECTOR has been named diode plant manager at *MicroSemiconductor Corporation*, Los Angeles manufacturer of micro-size semiconductors.

Before joining the firm, Mr. Spector was manager of processing in the reliability division of *Pacific Semiconductors, Inc.* and a process engineer at *Clevite Transistor Products.*

A specialist in operations research, Mr. Spector joins the newly organized firm at its 11250 Playa Court, Culver City, California plant.

* * *

ROY RAYMOND has been promoted to the post of national sales manager for *Stromberg-Carlson* stereo high-fidelity components and systems. He was formerly eastern regional manager for the firm's consumer products . . . *Waldom Electronics, Inc.* has appointed **HARRIS PRINCE** vice-president of sales . . . **MILDRED SCHWARTZBERG** has been elected executive vice-president and general manager of *State Labs, Inc.*, New York City distributor of tubes and components . . . **DR. JULIUS A. STRATTON** has been awarded the Thirty-Ninth Annual Faraday Medal by the Institution of Electrical Engineers for his notable contributions in the fields of technological education and research in radio communication. He is the president of Massachusetts Institute of Technology . . . **WILLIAM H. MOORE** has joined the EIA staff as vice-president of the military products division. He was a former Department of Defense official . . . **ARTHUR J. SEILER** has been elected vice-president and director of *Reeves Soundcraft Corp.* . . . . **E. R. CHAMPION** has joined the distributor division of *International Rectifier Corporation* as field sales manager . . . The appointment of **PAUL LITTLE** to the post of assistant sales manager has been announced by *Sherwood Electronics Laboratories, Inc.*, Chicago manufacturer of high-fidelity tuners and amplifiers . . . **DR. JEROME B. WIESNER** is the recipient of the 1961 EIA "Medal of Honor" for "distinguished service contributing to the advancement of the electronics industry." He is currently serving as the President's special assistant for science and technology . . . **WILLIAM F. KAISER** has been appointed director of public relations and advertising for *Daystrom, Incorporated* and its divisions and subsidiaries . . . **RICHARD O. AHLFORS** has been appointed national field sales representative for *Seco Electronics Inc.* of Minneapolis . . . **ORA F. KUHLMAN** has been named director of engineering for *Key Resistor Corporation* of Gardena, Calif.

* * *

STANCOR ELECTRONICS, INC. is the new name for **CHICAGO STANDARD TRANSFORMER CORPORATION.** The name was changed, according to the company, to more effectively describe the firm's line which includes a wide range of inductive devices and power supplies as well as transformers . . . **PENN CONTROLS, INC.** of Goshen, Ind. has acquired **PIONEER ELECTRIC & RESEARCH CORP.** of Forest Park, Ill. through an exchange of stock. No financial details were announced . . . **SECO ELECTRONICS INC.** of Minneapolis has been purchased by **DI-ACRO CORPORATION** of Lake City, Minn. and will be operated as a wholly owned subsidiary under its present management and name . . . **COLLINS FARLEY CORPORATION** has been established in Los Angeles covering the audio and language teaching fields. The mailing address is Box 34846 . . . A new distributing firm to handle the increased requirements of industrial accounts in the Upper Midwest area has been established in Minneapolis under the name of **INDUSTRIAL ELECTRONICS, INC.** It is a division of **MINNEAPOLIS BEARING CO.** . . . **AMERICAN TUBE BENDING CO.** has established a new subsidiary, **AT ELECTRONICS, INC.,** which will fabricate and distribute coaxial cable for the missile, rocket, space, telemetry, and communications field . . . **ELCO ELECTRONICS, INC.,** Michigan City, Ind. manufacturer of portable and console phonographs, has been acquired by **TELEX, INC.** of St. Paul, Minn. for a undisclosed amount of cash and an exchange of stock. -30-

STEREO COMPONENT SHOW

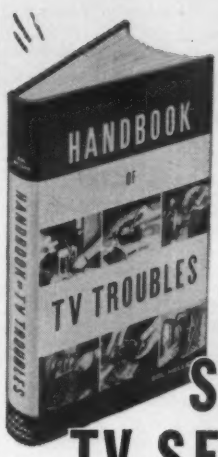
DEALERS in the Long Beach, California area have just staged a highly successful Stereo Components Exhibit which attracted approximately 1100 persons.

A unique feature of the Exhibit was the fact that the show was "silent." Components were shown in attractive room settings to demonstrate how well such audio equipment could be made to blend in with the home decor. Survey cards given out at the Exhibit indicated a preference of 2 to 1 for a silent show.

Nine Long Beach stereo dealers and their personnel were present and helped man the exhibits. They were most pleased with the type of crowd and indicated that, in their opinion, this was by far the most practical way to present stereo components and high-fidelity cabinets to the public. The dealers also reported a subsequent increase in walk-in trade at their stores which they attribute to the Exhibit.

According to Frank B. Koessler, show chairman, this was more or less a "pilot" presentation. Because of the success of the Long Beach show, other silent-type Exhibits are planned for outlying areas by the Audio Division of the E.R.A. (Electronic Representatives Association).

-30-



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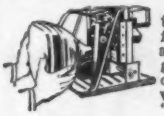

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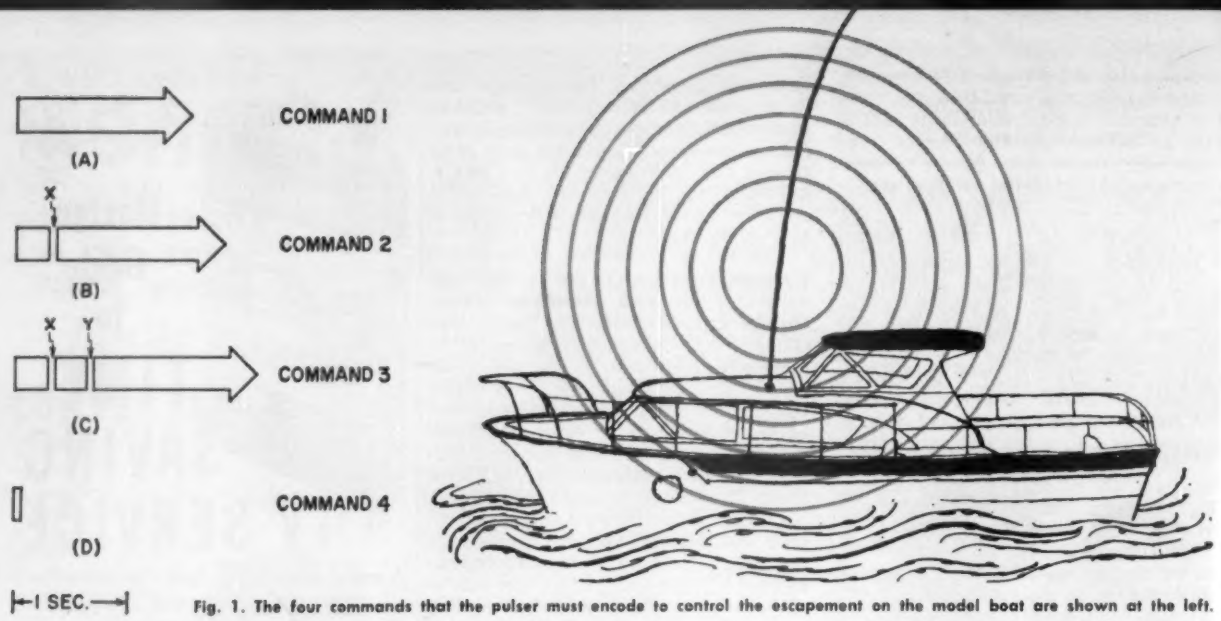


Fig. 1. The four commands that the pulser must encode to control the escapement on the model boat are shown at the left.

RADIO-CONTROL "BEEP BOX"

By JOHN G. CURTIS

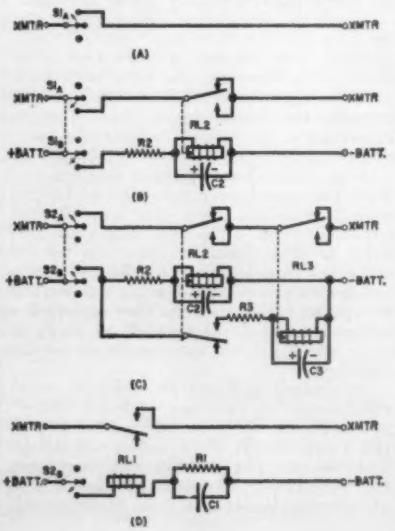
Construction of an automatic pulser that will encode 4 commands needed to operate a super-compound escapement.

MANUALLY pulsing a single-channel transmitter properly to actuate a super-compound escapement requires an educated and well-trained thumb. After using a push-button to pulse a transmitter for a 40-inch model *Chris-Craft*, it soon became evident that, due to the precise timing required, operation was limited to trained operators and even then there were embarrasing miscues. Wrong signals sent to model boats are usually not too serious, however in the case of model aircraft the results can be disasterous.

A glance through the radio-control manuals turned up various mechanical pulsers none of which was exactly suited to the job at hand. After a little experimenting, the author decided that the job could be handled electrically and set about building the pulser to be described.

This pulser was specifically designed to encode the four commands necessary for operation of a *Babcock* "Mark II" super-compound escapement. It has been in use for over two years and has yet to make a mistake. If the unit is neatly and sturdily constructed, it will give long years of service with only an occasional battery change. Battery drain is negligible and the batteries can be used for their normal shelf life.

Fig. 2. The four circuit configurations that produce the desired signals.



Operation of the Pulser

There are four commands which the pulser must encode in order to control the super-compound escapement. The first is a steady "on" signal (Fig. 1A), the second is an "on-off-on and hold" (Fig. 1B), the third is an "on-off-on-off-on and hold" (Fig. 1C), and the fourth is a short, momentary "on" (Fig. 1D).

In the model boat for which the pulser was designed, the commands were: (1) right rudder; (2) left rudder; (3) horn; and (4) motor control.

Functions 1, 2, and 3 can be held indefinitely and since the super-compound escapement always returns to neutral, the commands do not have to be given in sequence.

The pulser described here uses *RC* time-constants to provide the timing functions. Use of the dead space between the double-throw relay contacts

provides the momentary "off's" (points *X* and *Y* in Figs. 1B and 1C) which unlatch the escapement, allowing it to proceed to the next position.

The circuits used for each command are shown in simplified form in Figs. 2A through 2D. For command 1, the control switch S_{1A} merely closes the circuit for as long as it is held.

For command 2, S_{1A} closes the transmitter circuit through the contacts of RL_3; S_{1B} connects the coil of RL_2 to the 67.5-volt battery. The series resistor R_2 and the parallel capacitor C_2 delay the operation of RL_2 for about ⅓ second, allowing the model escapement to come to rest at position 1. When RL_2 is actuated, it momentarily interrupts the transmitter circuit and then remains energized for as long as S_1 is pressed. This releases the model escapement from position 1 and holds it at position 2.

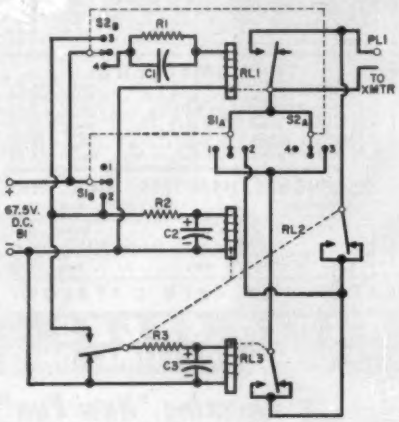
For command 3, S_{2A} closes the transmitter circuit through RL_2 and RL_3 contacts; S_{2B} connects the coil of RL_3 (with C_3 and R_3) to the battery. After about ⅓ second, when the escapement has come to rest at position 1 in the model, RL_3 actuates and momentarily interrupts the transmitter circuit allowing the escapement to unlatch from position 1 and proceed to position 2. In the energized position RL_3 connects the coil of RL_2 (with R_2 and C_2) to the battery. After ⅓ second, RL_2 actuates and again momentarily interrupts the transmitter circuit, allowing the escapement to proceed to position 3 where it is held as long as S_2 is pressed.

On command 4, the transmitter circuit is closed momentarily through the charging of C_1 through S_{2B} and RL_1. R_1 discharges the capacitor after S_{2B} is released. The escapement unlatches on receipt of this momentary signal and a circuit is completed through the "rest" contact of the receiver relay and a momentary switch between positions 0 and 1 on the escapement. This circuit can be used to actuate a second escapement, the motor-speed escapement in the case of the model boat built by the author.

Construction

The unit shown in the photo was constructed while the author was stationed in Japan which explains the use of Japanese components throughout. The resistors and capacitors are standard, however, and can be purchased at any radio supply house. The only component which is somewhat special is the d.p.d.t. 5000-ohm relay which is Japanese. *Lafayette Radio* catalogues these as #F-332. The toggle switches are d.p.d.t. momentary action, with center position off.

Parts placement and wiring layout are not critical but care must be exercised in making connections to the relay contacts because of the close spacing of the terminals. It may be a good idea to fan these terminals prior to wiring to prevent accidental shorting. Also be sure to observe polarity when connecting the electrolytics.



R_1—100,000 ohm, ½ w. res.
R_2,R_3—8200 ohm, ½ w. res.
C_1—.5 μf., 200 v. capacitor
C_2,C_3—30 μf., 150 v. elec. capacitor
RL_1,RL_2,RL_3—D.p.d.t. 5000-ohm relay (Lafayette F-332, see text)
S_1,S_2—D.p.d.t. momentary-on, center-off switch (Cutler-Hammer 8835-K3 or equiv.)
PL_1—Phone plug
B_1—67.5-volt battery (RCA VS082 or equiv. Use Cinch-Jones 5MFA connector)

Fig. 3. Complete schematic of the pulser.

The unit shown in the illustrations is housed in a 4" long x 2¾" wide x 3" deep custom-built aluminum box which contains all of the parts, including the 67.5-volt battery. A 5" x 3" x 4" standard chassis box should prove to be a satisfactory substitute. The original panel was etched from laminated plastic stock but neat hand lettering should suffice if you'd rather not bother with the trimmings.

Installation

The only transmitter modification necessary is the addition of a phone jack to receive the cable end from the pulser. This jack should be placed in parallel with the manual push-button (in the transmitter plate circuit) so that the transmitter may be manually pulsed when the plug and cable from the pulser is disconnected or when the pulser is accidentally left behind.

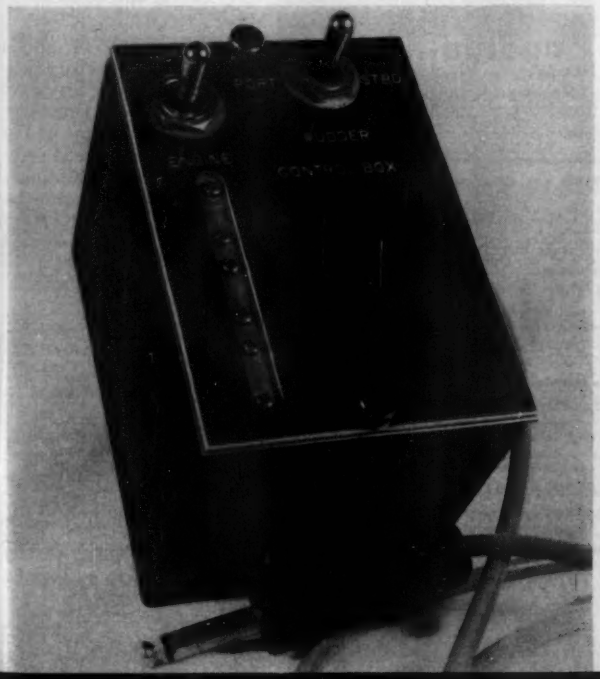
The battery should last its full shelf life with moderate usage, however it may be good practice to install a new one each year as insurance.

The only operating precaution necessary is to allow both the model escapement and the control box circuits to neutralize between successive commands. This normally requires less than a second.

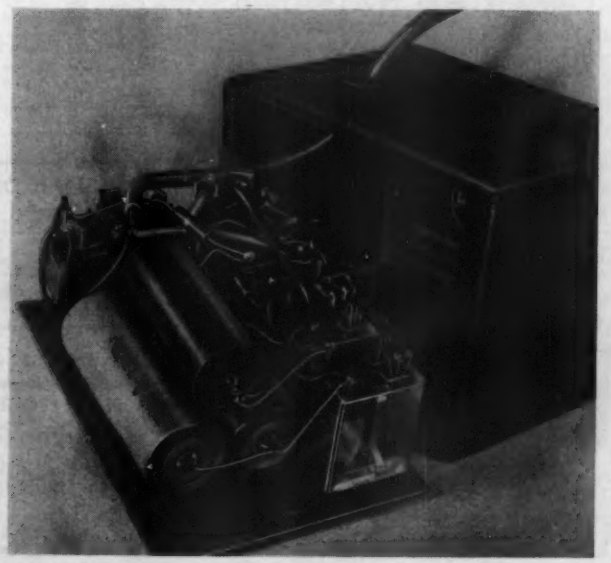
The escapement in the boat model for which this pulser was designed is quite fast acting, having practically no mechanical load to drive except Microswitches. If your particular application requires a slower pulsing rate, the values of C_2 and C_3 can be increased in proportion to the increased delay required. C_1 will normally not have to be changed.

Use of the automatic pulser will remove most of the possibility of human error from model operation and, in addition, allow unskilled enthusiasts the fun of "piloting." -30-

The pulser was housed in a 4" x 2¾" x 3" custom-built box.



Box contains battery, 3 relays, 3 RC circuits, and 2 switches.



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Stereo FM Multiplex System

(*Continued from page* 53)

by the FCC, as well as any other multiplex system that has ever been proposed, is subject to interference to a greater degree than the monophonic main channel. Ignition noise may perhaps sound louder; stray radiation from FM tuners, TV sets, and other transmitters may cause whistle tones to appear in the background; and the tube hiss of the first stage in the FM tuner will degrade the signal-to-noise ratio.

When listening to signals of marginal signal strength, the signal-to-noise ratio of the left- and right-channel stereo output signals will be poorer than the monophonic main channel by approximately 20 db. Measurements agree with this theoretical prediction to within a few decibels. The ultimate signal-to-noise ratio of the left- and right-channel outputs will be well in excess of 60 db. Because of the reduced signal-to-noise ratio when listening to stereo on weak stations, it will be desirable to have a directional outdoor antenna available to provide an increased amount of signal for the tuner.

The distortion which will result in a high-quality stereo multiplex adapter connected to a high-quality FM tuner will be on the order of ½% to perhaps 1%. This is considerably lower than the distortion in subcarrier detection employing other types of modulation. However, in listening to a station it is possible that considerable distortion may be experienced when listening stereophonically, yet relatively little distortion be present when listening monophonically. This increased distortion may be due to incorrect adjustment of the tuning control of the tuner or more likely is caused by a reflection of the station's transmitted signal from nearby buildings. This is an interfering signal. For this problem, correct adjustment of the tuning control, re-orientation of the antenna, perhaps a reversal of the antenna leads, will reduce this type of interference.

Tape recorder users will recognize that multiplex stereo broadcasting provides an opportunity to obtain good quality off-the-air recordings. However, during multiplex field tests some of the tape recordings which were made indicated that there could be definite interference problems. This is true since the bias frequency of many tape recorders is not far removed from the re-inserted carrier frequency or its harmonics. In well-designed adapters, these potential problems have been eliminated.

Multiplex can be a greater boon for the listener than was the development of the stereo record. The fact that certain problems have been mentioned in this article shouldn't cause too much consternation. You can't get something for nothing. However, with proper thought given to the selection of equipment and care taken in installation, the results should make the effort completely worthwhile. –30–

Electronic Crosswords

By MARGARET LeFEVRE

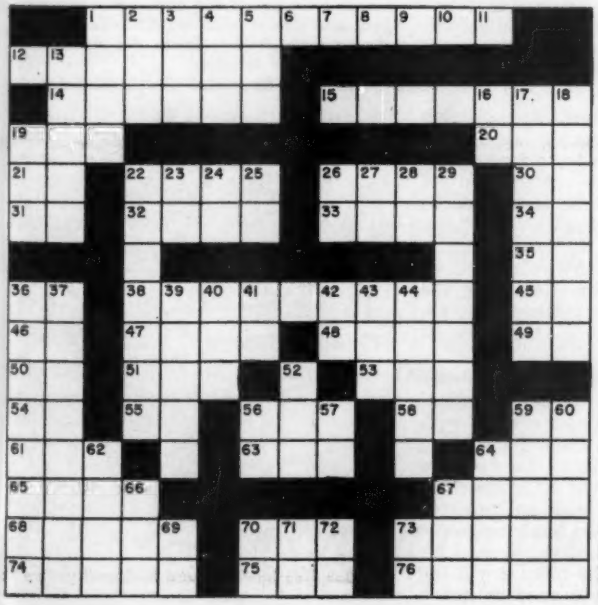
(*Answer on page* 107)

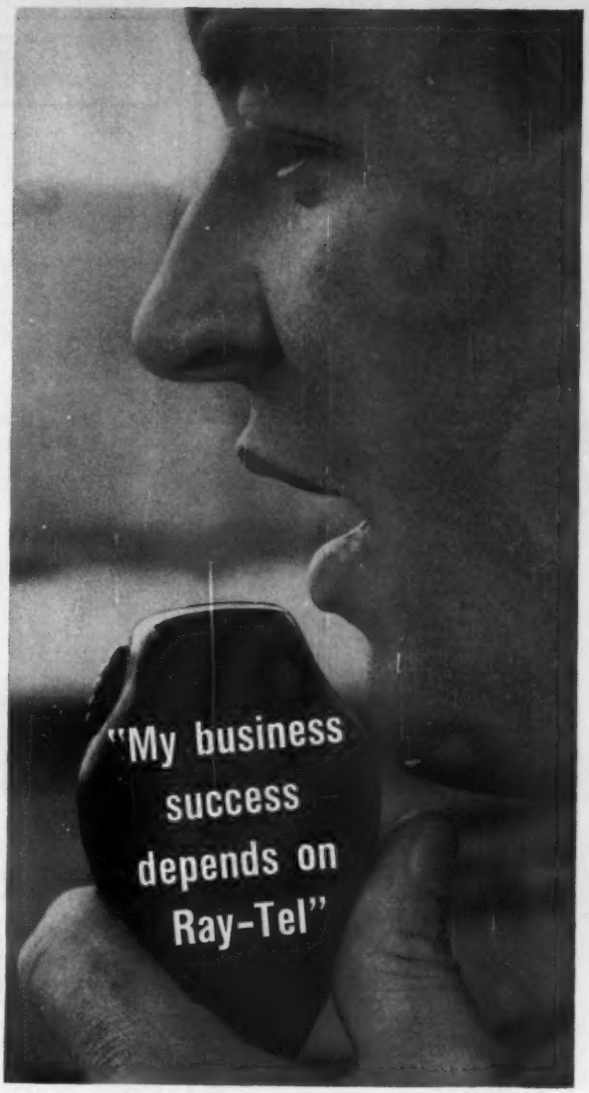
ACROSS

1. Message sending device of a ham station.
12. Pig-like.
14. Component of a speaker.
15. Device for controlling transmitting frequency.
19. Department (abbr.).
20. Prefix meaning "one."
21. Chemical symbol for silver.
22. Temporary connector.
26. Glass shell of a vacuum tube.
30. Old measure of capacity (abbr.).
31. West Africa (abbr.).
32. One of two equal parts.
33. A small island.
34. Engineering degree (abbr.).
35. The President's name contains these double letters.
36. Chemical symbol for rhenium.
38. Frequencies on either side of the carrier frequency.
45. Canadian province (abbr.).
46. Each (abbr.).
47. To cover a TV picture bit by bit.
48. Flat-bottomed boat.
49. Latin digraph retained in some scientific terms.
50. Schematic designation for a crystal rectifier.
51. Electrified particle.
53. Eggs.
54. A 45-rpm record (abbr.).
55. Chemical symbol for tin.
56. Code sending device.
58. Prefix meaning "formerly."
59. The Fifty (abbr.).
61. Indicated horsepower (abbr.).
63. Means of locomotion.
64. Suffix meaning "pertaining to."
65. Practical unit of potential.
67. One end of a magnet.
68. Man's name (var.).
70. Record of a station's activity.
73. This is used in tuning up a transmitter.
74. Gathers.
75. Diplomat (abbr.).
76. Attenuation network.

DOWN

1. Circuit used to eliminate interference.
2. Amplifier—input resistor (abbr.).
3. River in eastern France.
4. Compass point.
5. Receiver.
13. Greek letter used to designate "ohms."
16. It comes after "Blue Monday."
17. Conductor to radiate radio waves.
18. FCC permit to operate a ham station.
19. Bird.
22. Supporting metal base on which parts are mounted.
23. Sixth note in the scale.
24. He (Fr.).
25. Unit of capacitance (abbr.).
26. Prefix meaning "two."
27. Objective case of "we."
28. In the place cited (abbr.).
29. Insulating wax with fairly low dielectric loss.
36. Device for converting radio waves back into their original form.
37. "Personal" listening device.
39. Religious pictures.
40. Man's nickname.
41. Printer's measure.
42. While.
43. A master sergeant is one (abbr.).
44. Birds of "Peace."
52. Ocean.
56. 1000 cycles.
57. Unit of time (abbr.).
59. Leaderless.
60. Wise men.
62. Entreaty.
64. Very small quantity.
66. Coil connection.
67. Vim and vigor.
69. A contributory insurance program for employees (abbr.).
70. Chemical symbol for lanthanum.
71. A ham operator.
72. The British Isles (abbr.).
73. Unit of inductance (abbr.).





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Add A.F.C. to TV Sets

(*Continued from page* 50)

ous, your problem is not likely to be serious or difficult to clear up.

The first check: With the a.f.c. "on" tune to a vacant channel and measure the d.c. voltage across the silicon diode, CR_1. You should have about 1 volt of bias here. If an incorrect value is due to an error in the externally obtained bias voltage, manipulating resistor values in the voltage divider connected to the red lead will correct this.

Next measure the d.c. voltage from the discriminator (green lead) with a v.t.v.m. To do this connect your positive meter lead to the take-off point and the negative lead to ground. A zero-center scale will make things easier. It will also make things easier to perform this check on channel 13, where a maximum frequency swing can be obtained by turning the slug in the tuner's oscillator coil. Defeat a.f.c. While observing the meter, turn the slug with a tuning wand in toward the audio signal, until the picture is lost. In doing this, the meter should swing above and below the zero point. By rocking the slug, you should be able to swing the reading between a minimum of 2.5 to 3 volts positive and 2.5 to 3 volts negative. Actually, the swing may be a few volts higher, possibly going up to ± 7 volts. In any case, the positive and negative swings should be of equal, maximum amplitude.

If you do not get the proper readings here, your audio i.f. stage or discriminator may need re-alignment. Check to make sure. If alignment is satisfactory, you may have connected your green lead to the wrong point in the discriminator output. In some configurations, the correct spot is not obvious. Try those that look probable. In rare cases, the detector circuit itself may not be designed to provide the desired voltage. You may want to install one modeled after that shown in Fig. 6, using a pair of matched detector diodes. Or you may be able to alter the existing circuit accordingly, retaining many or most of the original parts.

As a practical matter, the need for re-designing the detector should be rare. This did not have to be done in any of the sets on which the author tried out the a.f.c. unit. If there is trouble in getting the circuit to work although the proper voltage swing at the detector is noted, the polarity of this swing may be in the wrong direction. Reversing the connections to the secondary of the detector transformer will take care of this problem.

Another possible cause of improper action is the fact that the bent terminal on C_1 is not making proper contact with tuner button Z. To check for a good electrical bond, observe the picture while gently prying the a.f.c. assembly away from button Z with an insulated screwdriver, and also by applying gentle pressure from the front to improve the contact. Effects on the picture will tell you whether contact is good or not.

You may run into one other problem. If you have good a.f.c. action on the lower channels but cannot lock in easily on, say, channel 13, then C_1 is set for too high a capacitance value. Reduce the setting of this capacitor until your highest channel locks in, and your job is finished. No other problems of any kind were encountered on any of the installations of the a.f.c. unit. If your tuner is different from the one used as an example, check it before planning your own physical layout and construction. If you cannot use the procedure exactly as described here, you may be able to adapt some or most of it. The output connection from C_1 to the oscillator circuit should be as short as possible.

A final word about the silicon diode used for CR_1. Although a specific unit is mentioned, many others will serve as well. Experimentation with several types showed that a total change in capacitance of more than 15 $\mu\mu$f. could be produced by the application of a reverse d.c. bias from .25 volt to 1.25 volt, which satisfies the requirements. Some standard, replacement, 500-ma. diodes of the type used as TV power-supply rectifiers were tried successfully, without any knowledge of their brand or type number. The builder may experiment, if he wishes. However, the one recommended is known to give excellent results.

Service technicians may find it profitable to sell and install this modification. It will be particularly attractive to customers who own remotely controlled TV sets and who complain of the tuning problem discussed earlier. -30-

HANDY TOOL DEMAGNETIZER

By CARL J. FAUST, Jr.

EVER wish you had a quick and easy way to demagnetize those screwdrivers and pliers that manage to pick up every loose screw and washer on the bench? If you own a soldering gun, you have a perfect tool demagnetizer. All you need do is place the tool in the loop formed by the wire tip of the gun, press the trigger, and slowly withdraw the tool about six or eight inches from the tip before releasing the trigger. -30-

"Bob, you haven't heard hi-fi until you've heard mine!"

Thermoelectricity

(*Continued from page 42*)

is among thermal conductivity, electrical resistance, and a special property called "thermoelectric power," *i.e.*, volts-per-degree of temperature difference.

Three general classes of materials must be considered. These are metals, semiconductors, and insulators. Their physical parameters, which govern their thermoelectric properties, are shown in Fig. 6.

Metals have enough electrons to be very good electrical conductors, yet standard metals are too inefficient for either refrigeration or power generation. Semiconductors have an intentionally restricted number of electrons, which gives them their desired characteristics as a class of materials. They are the most efficient, although their efficiency does drop off with an increase in temperature and very high temperatures are needed for efficient power generation. Finally, insulators have so few electrons that they make very poor conductors. Yet insulators do have the highest thermoelectric voltage, a desirable characteristic for power generation.

All told, semiconductors remain the most attractive class of materials for use in thermoelectric cooling and power generation. Present research to produce materials for thermoelectric cooling is based largely on the compound bismuth telluride (Bi_2Te_3). This formula, suitably modified, can demonstrate a heat pumping efficiency of 10 to 12 per-cent. However, because of mechanical properties, cost of raw materials, and other reasons, it has been replaced by a number of proprietary substitutes which have proven superior.

Recently, *Westinghouse* scientists have discovered a new class of materials which promises thermoelectric power generation at temperatures of about 2000 degrees F. These are known as mixed valence compounds of the transition elements. From a junction efficiency of one per-cent, achieved shortly after their discovery, efficiency has risen to about ten per-cent. Such a value is practical for a wide assortment of small-scale, specialized applications. Eventually, junction efficiencies with these new materials are expected in the 20 to 30 per-cent range, which would be comparable to what is achieved with semiconductors.

Beyond the question of materials are other factors that cannot be assessed at this time. Thus, it is impossible to predict just what thermoelectric devices and applications will be generally available—and when. On the basis of what has been accomplished up to now, and the continuing progress indicated by research, it does seem certain that these applications and devices will come, as welcome supplements to what we now have and as thoroughly new ways and means in our expanding electronic horizon. -30-

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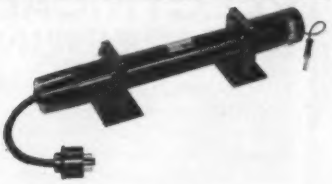

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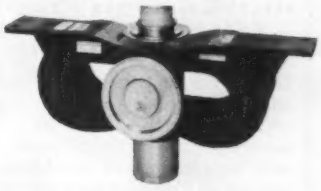

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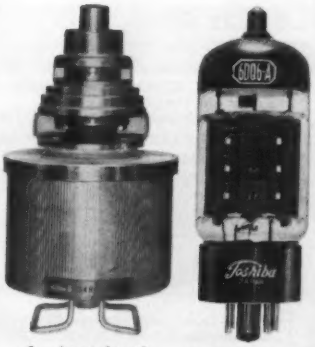

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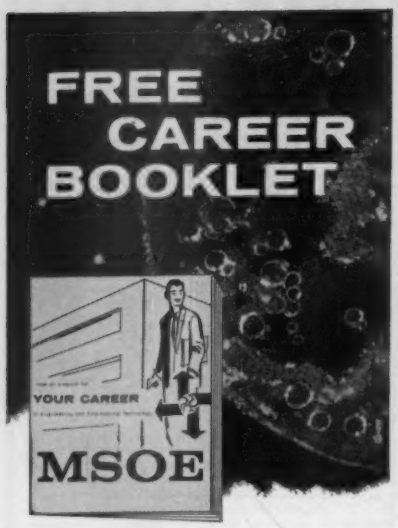

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Matching CB Antennas

(*Continued from page 33*)

which is present in a certain setup.

Throw the function switch to "Reflected." Trim the antenna a little bit at a time. The closer you come to the operating frequency, the lower will be the meter reading. Don't be surprised, though, if you are unable to obtain a 1 to 1 s.w.r. A loaded antenna may have an impedance below that of 52-ohm coax and so a perfect match is unlikely.

During the antenna tuning process it is helpful to have crystals for Channels 1, 11, and 22 on hand. Then you can switch from one frequency to another to find where the lowest s.w.r. is. If the meter is lowest on Channel 1, the antenna is a little long. If the lowest s.w.r. is on Channel 22, the antenna is too short. A low reading on 11, of course, means that the antenna is right on the nose for the middle of the band.

After the whip has been cut or telescoped to frequency, switch back to "Forward" and reduce the sensitivity control until the meter is at approximately half scale. On a mid-band channel, adjust the transceiver's final tuning control or coil slug for maximum output as indicated by the meter. Be careful, of course, not to exceed the 5-watt input limit.

Remove the reflected-power meter and reconnect the coax directly to the transceiver. Tune in a weak signal and adjust the slug of the receiver input coil to produce the greatest possible speaker volume. Since no two antenna systems are ever exactly alike, you will be wise to repeak the transceiver input and output circuits whenever you change from one vehicle to another.

A commercially built base-station antenna, when erected according to instructions supplied by the manufacturer, will normally require no pruning. However, if a check of the completed installation shows a s.w.r. much greater than 2 to 1, it will pay you to experiment with different element lengths. When doing this, you may connect the reflected-power meter at either the transceiver or antenna end of the cable. The latter position will provide slightly more accurate s.w.r. measurements.

A reflected-power meter is a one-impedance device. If wired for 50-55-ohm line, it will not perform correctly with 75-ohm cable. Since 50-55-ohm coax is generally employed for CB work, a 50-55-ohm meter will prove most useful. Should you find it necessary to check the s.w.r. on a 75-ohm line, the *Heath* AM-2 can be converted to this impedance by substituting two 100-ohm fixed resistors for the two 150-ohm resistors which are located inside the instrument's case.

Antenna Suggestions

Don't try to save money by utilizing a quarter-wave mobile whip as a base-station antenna. If you do, the results are likely to be disappointing, because a quarter-wave antenna must be operated in conjunction with a good ground. The ground serves as an electrical mirror which produces an image antenna as illustrated in Fig. 4. The whip, plus the image, is equivalent to a resonant half-wave antenna. During mobile operation, the car body forms the image. When a whip is perched atop a pole, however, there is no ground to furnish an image. The whip merely acts as a non-resonant antenna and offers a very poor match to the cable. Consequently, the s.w.r. is high.

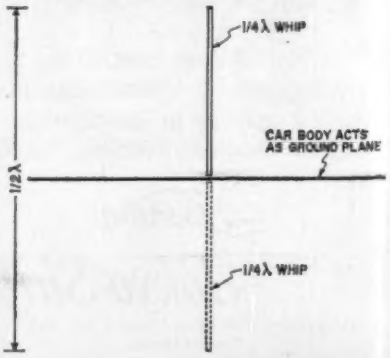
A ground may be simulated by mounting radials directly beneath the vertical as is done with the ground plane antennas of Figs. 3A and 3B. Adding radials to a quarter-wave whip in an effort to make it work properly, is a rather foolish procedure, though. You'll save time and money if you put up a correctly designed base-station antenna right at the start.

Although a 1 to 1 s.w.r. is the ideal toward which all CB operators should strive, the reader who has just purchased a base-station antenna may hesitate to attack his shiny new acquisition with a hacksaw, drill, pliers, and screwdriver, unless he can be certain that the tuning process will provide a marked improvement in performance. In general, if a check reveals that the s.w.r. is below 2 to 1, you will gain very little by attempting antenna adjustments. When an extremely long line run is required, beyond 150 feet for example, a 1.5 to 1 s.w.r. is worth going after if you want to squeeze the last bit of distance from your equipment.

A factor which is sometimes overlooked by the CB operator is antenna polarization. Maximum range can only be achieved if both the receiving and transmitting antennas are in the same plane. Try to avoid cross polarization. In other words, don't use a vertical antenna at one end of the link and a horizontal at the other. Vertical to vertical is best for mobile work. Horizontal to horizontal is superior for point-to-point communication between fixed stations.

Here is one final suggestion. Don't reduce the effectiveness of a good antenna system by hooking it to a misadjusted transceiver. Make sure that the input and output circuits of the base-station rig are carefully peaked as previously described for mobile units. —30—

Fig. 4. Quarter-wave whip plus image reflected by car body produces the equivalent of a resonant half-wave antenna.



Hum Elimination in Scopes

(*Continued from page 47*)

tive stages. If other changes have already been used, this one will provide the greatest reduction of any hum that may remain.

An external, low-voltage source, like a battery eliminator, can be used. It is advisable to bring leads for the filament wiring to terminals on the scope case, and also to mount a switch that will enable the choice of external d.c. or the internal heater supply. In cases where hum is not a disadvantage or where the instrument is to be used away from the d.c. supply, the normal heater arrangement may still be used. This method, which is the least expensive way of obtaining the d.c., worked well for the author for several months.

If the external supply is cumbersome, the user is ambitious, and some additional expense will be tolerated, the circuit in Fig. 4 can be used to provide an internal d.c. supply. It was adapted by the author from one appearing in a *Sylvania* handbook of transistor circuits. The 12-volt, stepdown transformer will not contribute hum if the CRT is properly shielded. If the transformer already in the scope can be adapted to this circuit, instead of adding one, so much the better.

The d.c. output of the circuit is about 9 volts with no load but drops to 6.3 volts as drain approaches one ampere, which is the maximum that should be drawn. This d.c. voltage could be applied to the heaters of tubes in the most sensitive stages first, and tube heaters could be added until proper voltage is achieved without excessive current. A good, well ventilated heat sink must be used. Despite the heat produced, this modification has been operating without any mishaps for six months.

Other Suggestions

If all the suggestions made so far have been followed, hum should be at a minimum. Any that remains (most likely in an instrument built from a kit) can be traced by manipulating lead dress while observing the effects on the scope trace. Establishing common ground points, with special attention on the early, high-gain stages, is also helpful.

It is often helpful to re-ground grid resistors by running jumpers from the existing ground points to other ground points showing less hum. This is best performed by probing for better grounds as follows: one end of the jumper wire is connected to the present ground for the grid resistor. An alligator clip is added to the free end and tried at various points along the chassis.

If the owner of the instrument really wants the improvement possible and has some patience, the methods here recommended will not disappoint him. He will be able to bring about the changes shown in the photographs accompanying this article. —30—

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FISHER "MICROTUNE" CIRCUIT

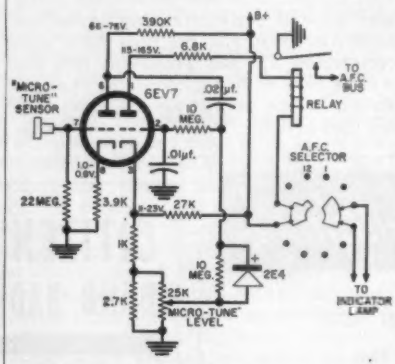
By JEROME M. GILISON

Fisher Radio Corp.

A NEW wrinkle in FM tuning automation, which should prove quite handy for most FM users, has been developed by *Fisher Radio Corporation* as its "MicroTune" circuit. The circuit is currently being incorporated in the firm's new 202-R FM-AM stereo tuner and the FM-200 FM tuner.

With "MicroTune" in operation, the a.f.c. is *automatically* turned off when the user touches the FM tuning knob and *automatically* restored when the user's hand is removed.

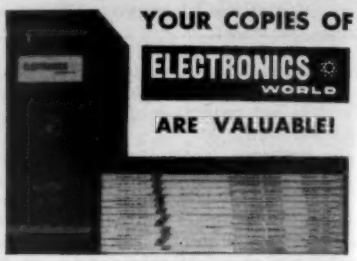
Normally, a.f.c. is added to an FM tuner to stabilize the local oscillator but in this design (with an oscillator stability of 0.02%), a.f.c. is used only as a means of increasing tuning accuracy. With today's wideband design, the flat-topped i.f. curve makes tuning for the precise center of the channel a delicate business, at best. Because of this, *Fisher* has added a.f.c., with a moderate pull-in ratio of 5:1, to correct the almost inevitable manual tuning errors. This, of course, created an additional tuning problem if the user inadvertently neglected to turn off the a.f.c. while bringing in the station of his choice. Thus "MicroTune" to the rescue to provide a foolproof method of automatically disabling the a.f.c. during tuning.



Circuit automatically disables a.f.c. when the user touches the tuning knob of the set.

How does it work? The FM tuning knob has been designed to act as a hum sensor. The natural capacitance between the knob and shaft was raised to a value of 25 $\mu\mu$f. by coating the inner surfaces of the knob with a special conductive paint. When the set owner touches the knob, the a.c. hum voltage induced in his body by house wiring is picked up by the capacitor knob, fed *via* the shaft and amplified in a two-stage amplifier (see the schematic).

The output of this amplifier is connected to a relay which switches a.f.c. out of the circuit. When the user removes his hand from the knob, the hum pickup disappears. This de-energizes the relay and re-inserts the a.f.c. by removing the ground connection from the a.f.c. bus. —30—



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Additional information on the items covered in this section is available from the manufacturers. Each item is identified by a code number. To obtain further details, simply fill in the coupon appearing on page 112.

New Products and Literature for Electronics Technicians

GRID BOARD KITS

1 **Corning Electronic Components** has released a series of prototype printed circuit kits which permit designers to set up "Fotoceram" grid boards in 15 minutes without leaving their desks. The kits contain the etching resists and etching materials that work best with the copper-clad "Fotoceram" glass-ceramic.

The grid boards are studded with .052-inch holes in a .1-inch grid, making circuit and com-

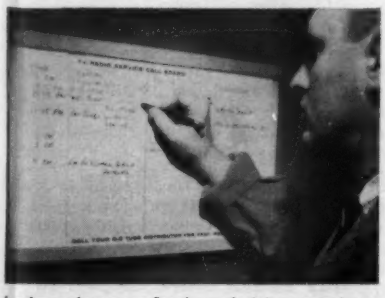
ponent layout highly manageable. Users etch away the copper metallizing on the boards except where circuit runs and pads are desired.

The kit contains two 3" x 5" boards, grid paper for practice layouts, liquid etching resist for board circuit layout, vinyl resist tape, two bags of persulfate crystals for making etching solutions, instructions, and a price list for re-ordering individual processing materials. The kit comes in a plastic box that serves as an etching pan. The liquid etching resist comes in a tube-pen with a ballpoint tip. The resist tape comes in a package consisting of 40 dots and 10 nine-inch strips.

SERVICE-CALL BOARDS

2 **General Electric Company's** Distributor Sales Operation has released a service-call board which is designed to assist service technicians in organizing their day's schedule for maximum routing efficiency and a minimum of missed calls.

Entries are made on a rotating plastic sleeve that is moved each day. The board holds seven



days' appointments. Service technicians can always see at a glance what is ahead for the next three days. The board is 21½" wide by 14" high.

HIGH-SENSITIVITY CELL

3 **Amperex Electronic Corp.** has announced the development of a miniature photoconductive cadmium sulfide cell with high sensitivity to visible light. Designated as the ORP90, the new unit features a dark current of only 2.5 μa. and an average cell current of 10 ma. with 5 foot-candles illumination.

Because of this high sensitivity and its high dissipation rating of 1 watt, the ORP90 can actuate relays directly, without need for the conventional amplification stage. The ORP90 is designed to be used in relay and illumination stabilizer applications. It is a side-sensitive device mounted in a hermetically sealed glass envelope with a conventional 7-pin miniature base, enabling it to replace directly phototubes now in use.

AUTO RADIO CONTROLS

4 **Centralab** has added five new units to its line of exact replacement auto radio controls—two for **Philco** and three for **Motorola.**

Part Nos. PP-58 and PP-59 are exact replacements for **Philco** Part Nos. 33-5580-21 and 33-5580-27 used in 1958 and 1959 **Plymouths.** Part Nos. DEM-59, DOM-58, and DOM-59 replace Part Nos. 18K561733, 18K560417, and 18B561732 used in **Motorola** receivers found in 1959 **DeSotos** and 1958 and 1959 **Dodges.**

V.T.V.M. IN KIT FORM

5 **Radio Shack Corporation** has added a v.t.v.m.-a.c. millivolt-wattmeter to its line of "Realistic" kits.

Featuring an exclusive accuracy switch which

doubles the a.c.-d.c. volt scale to provide greater accuracy for any reading by allowing measurements to be taken near full-scale meter indication, the new unit will also read standard v.t.v.m. ranges as well as provide accurate indication as low as 1 millivolt a.c.; a.c. current from .15 amp to 5 amps; up to 1600 watts at 110 volts a.c.; and audio output watts.

AXIAL-LEAD SILICON RECTIFIER

6 **Mallory Semiconductor Company** has announced the availability of a new series of axial lead silicon rectifiers with current ratings up to .5 ampere at 100 degrees C. The new "A" series rectifiers have a cold case design to eliminate shorting by contact and are encapsulated in a special material for humidity protection, exceeding by 400% the requirements of MIL-202A, Method 6 for hermetically sealed units.

The rectifiers are available with maximum allowable peak reverse voltage of 50 to 600 volts. Ambient operating temperature is −55 to +125 degrees C and storage temperature is −55 to +150 degrees C. Cases have a maximum length of .375" and a maximum diameter of .220".

UNIVERSAL IMPEDANCE BRIDGE

7 **John Fluke Manufacturing Co., Inc.** is currently offering a universal impedance bridge, the Model 710A. The new unit is capable of meas-

uring the capacitance and dissipation factor of capacitors, the inductance and storage factor of inductors, and the a.c. and d.c. resistance of resistors.

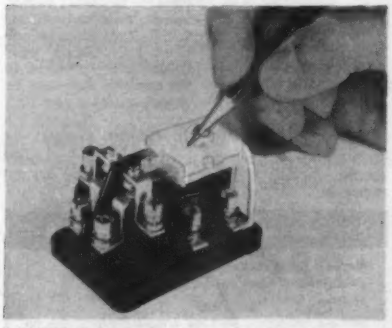
The Model 710A weighs only 10 pounds and measures 9" x 7" x 6½". Resistance is measured in 8 ranges from 0-12 megohms, accuracy is ± 0.1% + 1 dial division; capacitance is 0-1200 μf. in 7 ranges at ± 0.2% + 1 dial division; inductance covers 0-1200 hy. in 7 ranges; while dissipation is 0-1.000 at 1 kc.

MULTI-POLE RELAY LINE

8 **Ward Leonard Electric Co.** has introduced a new line of multi-pole relays engineered for industrial electronic control use. Tradenamed "Nyline," the new magnetically operated relays feature compactness, low cost, and high reliability.

Available in 2-, 3- or 4-pole, double-throw forms, all of the relays may be equipped with coils for a.c. operation to 230 volts maximum and d.c. to 115 volts maximum.

The 4-pole relay measures only 2¾" x 3¼" x



1-29/32". Relay contacts, rated at 10 amperes, are self-aligning and self-cleaning.

12-VOLT POWER PACK

9 **T. J. Bender Co., Inc.** is now offering a 12-volt d.c., 5-amp output power pack for use in displaying AM and FM auto and marine electronics

Tom McCann, President
NATIONAL TECHNICAL RESEARCH LABORATORIES

Are you tired of wading through page after page of repair books, cross indexes, complicated theory and a long list of possible sources of trouble . . . THEN, you will welcome an entirely NEW TROUBLESHOOTING TECHNIQUE which has been developed through thousands of hours of research in our Shops and Laboratories PLUS extensive actual On-The-Job Radio and TV repairs . . . Mail Coupon for Free Information Now!

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Your Radio problems will disappear fast when you put this Chart Unit to work. Spots troubles so quick it will amaze you. All models. Here is an entirely new non-mathematical approach that will be appreciated by the practical technician. The material contained in the Radio Tele-Vue Troubleshooter was obtained under actual shop conditions.

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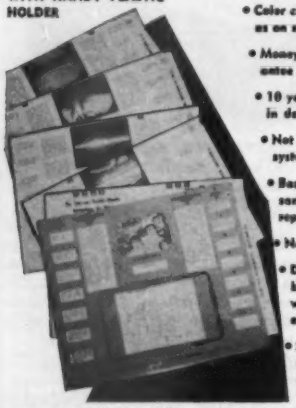

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COURSE 2 **BLACK & WHITE TELEVISION**

The techniques and shortcuts of TV Troubleshooting are fully covered in this 14-Point Course Unit. No guesswork! With the aid of actual photos of the trouble, you can rapidly isolate the exact trouble with a series of one or more checks that pinpoint what is wrong accurately. Technicians everywhere praise its accuracy . . .

COURSE 3 **COLOR TELEVISION**

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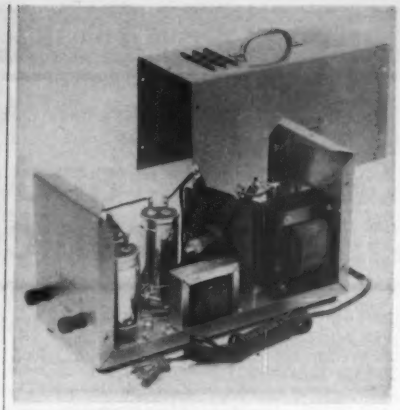


equipment, testing auto and marine motor ignition systems, charging batteries, and testing transistor circuits.

The Model 305 can be operated from any 117-volt, 60-cycle power line and provides an output d.c. ripple of less than 3/10 of 1 per-cent at 3.75 amperes. The pack is housed in a rugged metal case suitable for service shop and laboratory applications.

AUTO-RADIO TUBE CHECKER

GC Electronics Co. has developed an easy-to-operate auto radio tube and vibrator checker which is being marketed under the firm's "Vis-U-All' label.

Designed for use by gas stations, garages, car dealers, and auto radio service depots, the unit measures 17" x 15" x 8". Storage space in the unit holds replacement tubes and vibrators. The tester operates on any 117-volt, 60-cycle a.c. outlet and weighs 23 pounds.

UTILITY PLIERS

Xcelite, Inc. is now marketing a new forged alloy steel utility plier in 7" and 10" lengths. Featuring double-strong box joint construction and flush-ground rivet pin, the new plier is 30% thinner than conventional models.

For use on flat, square, hex, or round-shaped objects, it is designed to produce powerful leverage in each of four gripping positions with no sideway twist or strain. Simple, lever action movement of the handle quickly adjusts serrated jaws to the desired opening.

CHECK-TUBE CONVERTER

Antronic Corporation has announced the availability of a new check-tube converter, the "Anchor" TV-438, which enables bench testing of any TV receiver using existing substitute TV tubes.

Developed specifically for TV service technicians, the unit permits TV chassis to be brought into the shop for servicing without transporting the picture tube. Whether the TV receiver is a new 110-degree small-neck model or a large-neck 90-degree model, the TC-438 adapts to the substitute TV tube with only one setting. Correct voltage and current for all six combinations are supplied by the converter.

REPLACEMENT LOOP ANTENNAS

Vidaire Electronics Mfg. Corp. now has available two new flat ferrite-loop antennas which have been specifically designed as replacements in transistorized pocket-type radio receivers.

The Model LA-21 is for use with 211 $\mu\mu$f. variable capacitors while the LA-36 is designed for 365 $\mu\mu$f. variable capacitors. The company estimates that these two units will replace approximately 80 per-cent of all flat loops used in imported or domestic radio sets. The "Q" of each loop is on the order of 300. Inductance is adjustable for proper tracking by sliding the winding on the flat ferrite rod.

ROOFTOP ANTENNA MOUNT

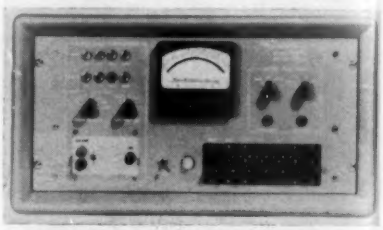
Technical Appliance Corporation is now offering a new "Bi-Mount" for both FM and TV antennas. The new unit is available in two models—"regular" for short masts and "super" for 10-foot masts.

The "Bi-Mounts" are designed to be used with all types of antennas and can be installed on any roof—flat or pitched, on one side, or straddling the peak. It eliminates the need for chimney mounts and, by using the mast as one of the legs, provides greater strength, rigidity, and ease of installation without the need for guy wires.

DIODE TESTER

Trans Electronics, Inc. is on the market with an advanced model of its diode tester which features expanded capabilities in the semiconductor low-current and high-voltage ranges.

The Model DT-924 is a back-current and saturation-voltage tester with meter ranges of 0-3000 volts, 0-3000 μa., and 0-3000 millimicroamps. Pres-



ent voltage ranges of 0-100-300-1000-3000 are provided and current ranges of 0-30-100-300-1000 are selected by keyboard switching. A three-position rotary switch selects the proper multiplier.

Design features include recorder output; 4½-inch mirror-back, 1% meter in fully protected electronic metering circuit; and current-limited, regulated power supply.

TRANSISTOR HEAT SINKS

Augat Bros. Inc. has added a new line of power-transistor heat dissipators, designed to utilize a minimum of space while maintaining low thermal resistance with natural draft. When used with forced air cooling, to which the dissipators are readily adaptable, even lower resistance is possible.

The units are being offered in three forms to accommodate TO-3 transistors and diodes, TO-36 transistors, and **Westinghouse** Type 2N1015 transistors.

TUBE-PIN STRAIGHTENERS

CBS Electronics is now supplying its miniature tube-pin straighteners in three models—supplementing the original bench-mounted Model SH-17 and SH-19. The new SH-79 is a convenient hand tool which may be carried in the tube caddy. It combines a 7-pin straightener on one end with a 9-pin straightener on the opposite end.

The SH-97P offers a separate pair of 7- and 9-pin straighteners for mounting on a chassis in standard cut-outs for miniature tube sockets.

PRECISION RESISTOR LINE

Ward Leonard Electric Company has entered the low-wattage precision resistor field with a line which will be marketed as "Metohms."

The resistors are initially available in three sizes: ⅛, ¼, and ½ watt. Standard resistance tolerance is ±1% with tolerance available to ±0.05%. Four standard temperature coefficient tolerances for each of the three sizes, range from ±150 ppm down to ±25 ppm, over the tempera-

ture range of −55 to +165 degrees C. The line is built to meet the requirement of MIL-R-10509C.

SUBMINIATURE ELECTROLYTICS

19 **Cornell-Dubilier Electronics Division** is now offering a line of "Electromite" subminiature electrolytic capacitors with aluminum cases and an all-welded construction that is said to assure elimination of intermittents.

Capacities from 1 to 450 μf. are available in cases from 3/16" x ½" to ½" x 1½", making them suitable for applications in miniature equipment where compactness, light weight, moderate cost, and a high-order of electrical-mechanical dependability are important design factors.

The capacitors are available in nine popular d.c. working-voltage ratings—3, 6, 10, 12, 15, 25, 50, 100, and 150. The units meet NEMA and MIL-C-62A standards.

EXPANDED BATTERY LINE

20 **Burgess Battery Company** has expanded its line of mercury cells and batteries to include a full selection for wide-range industrial, instrument, and electronic applications requiring constant-voltage power sources.

From the 17 basic types of mercury cells in the line, a virtually unlimited variety of multiple-cell batteries can be designed to meet varying specifications for space, weight, voltage, battery life, or other special conditions. In addition to these basic standard cells and multiple cell batteries, more than 60 types of mercury batteries are available on special order and others can be designed to customers' specifications.

METAL INSTRUMENT CABINETS

21 **General Metal Products Company** is now marketing a new line of steel cabinets with blank aluminum front panels which are especially designed for radio receivers, test instruments, intercom systems, ham gear, and other electronic assemblies.

The cabinet proper is one-piece 20-gauge steel, with re-inforcing angles and with an extra re-inforcing rib on the bottom. The back is spot-welded and angles support a 1/16" aluminum front panel. This panel is held in place by four knurled and slotted military-type screws. Two removable chrome-plated handles (optional) can be provided. Side louvres supply ventilation.

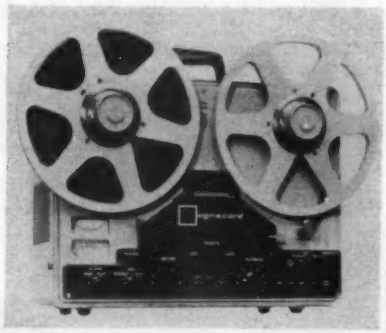
The cabinets are finished in black wrinkle and the front panel is gloss grey. Four rubber feet provide support. Currently available enclosures include 12½" long x 5" high x 5½" deep and 12½" long x 5" high x 11" deep models.

HI-FI—AUDIO PRODUCTS

TAPE RECORDER

22 **Midwestern Instruments, Inc.** has announced a new addition to its "Magnecord" line of tape recorder/reproducers.

The 748 series has 3.75 and 7.5 ips tape speeds, permitting up to 6 hours of uninterrupted program at the lower speed. The unit is capable of stereo, mono, and sound-on-sound recording. It will accommodate up to 10½" reels and can be ordered with half-track or quarter-track play



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heads. It is available for custom cabinet or rack mounting or with a portable case.

A direct-drive hysteresis synchronous motor provides timing accuracy of ± 3 seconds in 30 minutes playing. At 7.5 ips response is 40-15,000 cps ± 2 db. Flutter and wow is held to 0.15%.

Preamp output is 2 volts and inputs are through two high-impedance microphones and two high-impedance bridges. Low-impedance inputs and outputs are optionally available through the use of nominally priced input and output transformers.

AUDIO OSCILLATOR MODULE

23 **Henry Francis Parks Laboratory** is now offering an audio oscillator module which is suitable as a 60-, 400-, 440-, 800-, or 1000-cps frequency standard or as a fundamental tone generator for electronic musical instruments.

The Model 101 has a frequency range of 20-12,000 cps, adjustable to any frequency throughout this range. Operating voltage is 6-22.5 volts d.c. with output voltage 4 volts into a resistive load of 250,000 ohms at an input of 20 volts ± 1 volt.

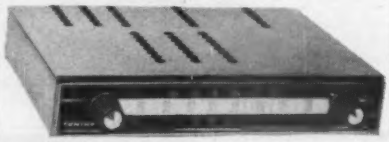
The standard unit is adjusted at 1000 cps, frequency not designated. The factory will set, lock, and print specified frequency without extra charge.

The module measures 2.125" x 3.25" x 1.060" and weighs 4 ounces.

FM CAR RADIO CONVERTER

24 **Granco Division** is now marketing its Model ARC 60 FM car radio converter with automatic frequency control.

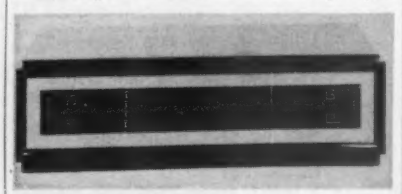
The new unit is completely battery operated (12 volts) and requires no power packs or vibra-



tors. The instrument utilizes the existing car radio antenna and circuits. The compact design permits the converter to be installed quickly and easily under any dashboard. The unit, which is 1¼" thick, can be mounted with just 3 screws, a single wire, and antenna plug-in. The circuit features the firm's exclusive "Auto-G" coaxial tuner for maximum sensitivity and selectivity.

BENCH-MOUNTED SPEAKERS

25 **Scott Radio Laboratories** is marketing a unique stereo speaker system which is housed in a single enclosure—a distinctively styled



oriental bench finished in satin ebony with a hand-painted motif in Chinese red.

Designated as the "Custom Stereo System M-1200," the unit includes the M-100 dual woofer and M-200 deluxe mid- and high-frequency reproducers. Measuring 14" x 46" x 18", the unit covers the full audio spectrum.

FM TUNER/AMPLIFIER

26 **Sherwood Electronic Laboratories, Inc.** is now offering its Model S-8000 FM tuner/amplifier featuring two 30-watt amplifiers, two complete phono preamps, and stereo control amplifiers.

The circuit includes one "acro-beam" tuning eye, inter-channel hush, and 7" expanded dial scale for FM, balanced flywheel tuning knob, friction-locked stereo bass and treble controls, ganged loudness control, phono level control, stereo balance control, and stereo function and input selector switches.

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3. ***Color Codes Chart:*** Gives you coding for capacitors, resistors, transformers, resistance control tapers—all in easy-to-use form.
4. ***Bass-Reflex Design Charts:*** Complete data on building own bass-reflex enclosures for any speaker, including ducted-port enclosures.
5. ***Radio Amateur Great Circle Chart:*** For Hams and short-wave listeners—gives complete listing and map of amateur prefixes by calls and countries.

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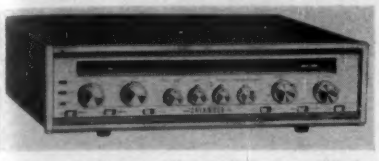
VALPARAISO TECHNICAL INSTITUTE
Dept. RD **Valparaiso, Indiana**

Six slide switches control scratch and rumble filters, FM a.f.c., phase reverse, and tape monitor. Inputs are provided for tape playback, tape monitor, phono, AM tuner, and two auxiliary sources.



Outputs are for recording and 4-, 8-, or 16-ohm speakers. A special feature is provision for inside-the-unit installation of an FM multiplex adapter.

Output is 32 watts music power each channel at 1½% IM distortion; response is 20-20,000 cps @ 30 watts; while hum and noise is 60 db below 30 watts on phono input. The unit measures 16¼" x 14" x 4½".

TRANSISTORIZED AUDIO AMP

27 **Wm. A. Holmin Corporation** is offering a new portable, transistorized audio amplifier especially designed for the commercial sound market.

This 10-watt unit operates from two to four 6-volt self-contained, lantern-type batteries. The circuits are designed to be used with almost any

type of microphone and almost any type of 4-, 8-, or 16-ohm speakers. Mixing circuits permit simultaneous use of microphone and phonograph. Separate bass and treble controls are provided. Either high- or low-impedance microphones can be accommodated.

The amplifier is housed in a convenient carrying case equipped with an adjustable shoulder strap.

SPEAKER SYSTEM FOR ORGANS

28 **The Schober Organ Corporation** has released its new LSS-10 loudspeaker system which has been exclusively designed as an external speaker system for electronic organs.

The LSS-10 is a ducted-port enclosure tuned to 32 cps in conjunction with an Electro-Voice SP12B speaker so that it reproduces full fundamental energy at this low frequency. Above the unusually low electrical crossover point at 300 cps, an LS-8 speaker, mounted in its own sub-enclosure, beams treble to the ceiling so that the high frequencies are diffused.

This external speaker system can be easily connected to any organ without soldering. The system is powered by the organ's own amplifier and gives volume equal to or greater than the original speaker. For larger organ models without built-in speakers, the LSS-10 can be coupled to any high-fidelity amplifier of 20 watts or higher rating. An

IF IT'S ELECTRONIC, GET IT FROM GOODHEART!

NAVY'S PRIDE COMMUNICATIONS RECEIVER

RBS. 2 to 20 mc, 14-tube Superhet made by Stromberg-Carlson to exacting Bu-Ships specs, strictly for Communications. Low-pass filters cut off above 3500 cy, which is ideal for Voice and CW intelligence. Special Output Limiting ckt saves ear's ears, keeps a 3 mw output same at 100,000 uV as at 5 uV. 4 bands. Vernier dial has 10-turn 0-1000 logging calibrator for each band; vernier divisions range from .0016 to .006 mc. Sensitivity 2.5 to 4.3 uV. Average Selectivity: Signal 7.55 kc away must be 10 times as strong. Image and I.F. Rejection: Average 100 db. Has noise limiter, AVC-MVC, BFO, Pitch, RF & AF Gain controls. RF, Mixer, 2 I.F.'s, are 12SG7's. Osc., BFO, & 2nd AF are 12SJ7's. Det/Noise-limitor & AVC are 12H6's. 1st AF & AF Phones output (600 ohms) are 12SN7 & 12A6. 8-watt AF output (600 ohms) is P-P 6V6's. Rect. is 5U4G. Input 115 V, 50/60 cy, 1 ph. Use your B'cast-Band rcvr for double-superheterodyning if you wish because I.F. is 1255 kc. Receiver is 35 lbs. 14" wd, 10" high. Pwr sply/AF ampl. is 56 lbs, may be placed anywhere convenient and out of the way. In excellent used condition. Each has been put through a shop, checked out and aligned. Comes to you complete, ready to plug in and use. Perfect operation guaranteed. With schematic & instructions. Shpg wt 120 lbs fob Charleston, S.C. A Best Buy! Only $99.50
Time Pay Plan: $24.50 down and 5 mos. at $15.68/mo.

RADIO RCVR AND/OR SPECTRUM ANALYZER

AN/APR-4 Receiver Unit, ready to accept plug-in tuning units from 38 to 4000 mc. This is the 30 mc I.F. ampl. with choice of 0.6 or 4 mc pass band, for communications or for Noise & Spectrum analysis. Has built-in 120 v. 60 cy power supply, Panadapter output, Video output, Phones outputs, S-Meter, BFO, and Volume control. DO NOT CONFUSE with the much earlier model APR-1; this is APR-4! Electrically checked and certified, less tuning units, 40 lbs fob Los Angeles . . . $69.50
Add $85.00 for set electrically-certified TN-16, 17, & 18/APR-4; takes you 38-1000 mc. Add $59.50 for electrically certified TN-19, 1000-2200 mc.
Time Pay Plan rcvr & T.U. 38-1000 mc as above, $36.50 dn & 7 mos at $16.32. To 2200 mc, $54.00 down and 10 mos at $16.25.

CAPACITY AND RESISTANCE AC BRIDGE

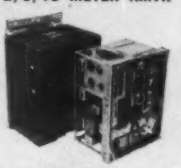
Navy ±60007, made by Clough-Brengle. Complete, no batteries needed. Input 120 v, 50/60 cy. Measures: C from 10 uuf to 100 uf; electrolytic leakage current on scales 0-1, 2½, 5 ma (with polarizing voltage 0-550 v dc); power factor 0-50%; R 1 ohm to 1 megohm; insulation resistance to 2500 megs; transformer turns ratios from .001 to 1000. Accuracy ±5%. Checked out, guaranteed, with tubes and instructions. Shpg wt 22 lbs fob Los Angeles, only $37.50

TS-34/AP Test Scope is in use today in many Navy shops for general-purpose and radar service. Ready to use on 120 v, 50/60 cy. Sweeps 10-50,000 cy. Video flat 40 cy-2½ mc, useful to 4 mc. Attenuators so accurate can use as VTVM. Has switch position in which each pulse to be studied, pos. or neg., triggers its own sweep, delays itself, then shows up stationary, 1 per sweep, with sweep duration choices of 5, 50, or 250 usecs. Ideal for TV pulses. Built-in lens enlarges 2" screen to 5" image; light shield shows up vertical rises. In carrying case, w/reprint of 17 book pages, less cords, checked for sweep & deflection. 50 lbs fob Los Angeles, only . . $39.50
(Add $10.00 for set of cords & HV probe.)

SCHEMATICS/CONVERSIONS, SURPLUS GEAR

Ask us for your needs: send stamped addressed envelope. Add 25¢ for chart explaining AN Nomenclature. Examples of available literature: 20-page book on 1-177, with diagram of MX-949/U socket adapter, & tube data compiled to March 1957, $5.00. RT-18/ARC-1 schem. & tune-up instr. $2.00.

2-METER RECEIVER & 2/6/10 METER XMTR



SCR-522-C: Latest production Receiver BC-624-C has all 12 tubes, electronic squelch, improved cascade AVC, more output. Transmitter BC-625-AM has all 7 tubes including 2 832A's. Both units mtd in rack and case, 100-156 mc AM 4-channel xtl control, very clean, as removed from aircraft. FOB Bremerton, Wn, or Buffalo, N. Y. $19.95
Same, "A" Model, has relay squelch $16.95
For either model, add $3.00 for complete technical data: Original schematics, all models, parts lists, I.F., xtl formulas, instructions for AC pwr supply, for rcvr continuous tuning, for xmtr 2-meter use, and for putting xmtr on 6 and 10 meters.

0.1% SORENSEN Line Voltage Regulator

±50008. Brand new at low surplus price! Input 95-130 V, 1 ph., with taps for 50 or 60 cy. Use for any power up to 5000 watts. Output adjustable 110-120 V and holds to ±0.1% at line frequency, or to ±0.25% if line frequency drifts 5%. Regulates against line changes of 95-130 V and against load changes from 0 to 5 KVA. Maximum harmonics less than 3%! Recovery time 0.15 seconds. Input to the control section can be moved to the point where you will use the power, thus compensating for line drop. In rack cabinet 28" h, 22" wd, 15" dp. Net wt 190 lbs. Shpg wt 285 lbs FOB Utica, N. Y. In original factory pack suitable for export, including SPARE PARTS group. Sorensen catalog: net price is $695.00 less spares. Our price, WITH SPARES $349.50
For other regulators, Sorensen & Sola, see our ad June issue p. 107. Delete 3kva Solas, sold out. Add new acquisitions: Sorensen ±10,000S, same as ±5000S above except 10 kva; overhauled & certified by Sorensen, fob S. Norwalk, Conn., $595. General Radio ±1570-AL (electromechanical) regulator holds output setting 103-126v, 1 ph 60 cy to ¼%, for inputs 103-126v, or to ½% for inputs 92-138v, at any output current up to 50 Amps! Certified like new. $265 fob Los Ang. Superior Stabilines: 1.3 kva, 120 v, 50/60 cy $87.50 fob Los Ang. 3 ph 50/60 cy units: 208 v, 9 kva, $395. 230 v, 10 kva, $495. Both new, fob N.Y. City.

NOTES TO OUR FRIENDS:

1. See our ads March p. 117, May p. 98, June p. 107, for pulse generators, tuning-fork oscillators, pen-recorders, signal generators, how to improve rcvrs.
2. WE WILL BE CLOSED FOR VACATION AND TO CATCH UP ON UNFINISHED PROJECTS DURING AUG.

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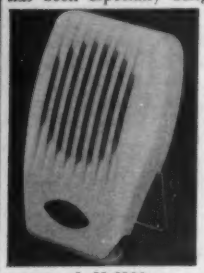
amplifier may also be used with the system to make a small organ suitable for church or auditorium use.

The enclosure measures 24" x 19" x 36". The unit will handle 40 watts of organ tone and covers a uniform frequency range of 32-13,000 cps.

TAPE-RECORDER MICROPHONE

29 **Turner Microphone Company** has added a new microphone, the Model 607-608, to its product line. This thin, lightweight microphone has been especially designed for use with tape recorders.



A feature of the new unit is the fold-out stand which makes the microphone especially useful in conference or round-table discussions. The stand folds neatly into a compact unit for easy storage.

Housed in a durable polystyrene case, the Model 608 has a response of 60-8500 cps and −45 db level. The Model 607 has a ceramic interior with the same response as the Model 608 but with a −55 db level.

MINIATURE TAPE RECORDER

30 **International Products Co.** is now marketing a compact, transistorized tape recorder as the "Diplomat."

The unit is housed in a durable metal cabinet with built-in speaker which measures 7¾" x 5¾" x 2½" and weighs 3.7 pounds. The instrument will play and record at either 1⅞ or 3.75 ips speed. A single control knob operates the unit.

Accessories, which come with the recorder, include an a.c. adapter to conserve batteries, stereo headset, footswitch, leather case, telephone pick-up, level meter, remote microphone, etc.

The recorder is powered by six penlite cells and covers a range of 150-6000 cps.

STROBE/TAPE KIT

31 **Robins Industries Corp.** is now offering a new tape strobe and light kit for use with any tape recorder.

The "Strobetape Kit Model TK-5" consists of five lengths of 25-inch non-magnetic leader tape with stroboscopic markings and a small neon light which flickers at the rate of 120 times per second. The leader can be spliced into a roll of tape at intervals to check performance of a recorder or it can be used as a leader.

By making an endless loop of the tape, the speed of the capstan can be tested.

AUTOMATIC TURNTABLE

32 **Benjamin Electronic Sound Corp.** is now offering the "Miracord Studio-H" fully automatic turntable which features a hysteresis motor for absolute speed control.

The instrument features a 12", non-ferrous one-piece turntable weighing seven pounds, dynamically balanced. The special "Magic Wand" spindle eliminates cumbersome changing mechanisms. The instrument is also supplied with a manual spindle for single-record play.

The turnable can handle all four speeds and plays all records automatically, including the new 33⅓ rpm 7-inch types. The turntable comes complete with professional-type tonearm. A new positive-locking plug-in head will accept all cartridges now in use.

MATCHED-PAIR AUDIO TUBES

33 **International Electronics Corp.** has announced an expanded line of **Mullard** laboratory-balanced matched pair tubes, designed to permit optimum performance of quality high-fidelity equipment.

Currently available in the new "dual-tube" packages are: EL34/6CA7, EL37, EL84/6BQ5, EL86/6CW5, EL90/6AQ5, EL95/6DL5, ECL82/6BM8, UL84/45B5, and 7189.

REPLACEMENT SPEAKERS

34 **Rockbar Corporation** has announced a newly expanded line of **Goodmans** replacement loudspeakers. Among the units currently available are a new 3½" tweeter, a series of 6" inverted-type speakers, 4" x 6" elliptical speakers, as well as 8" x 5", 9" x 6", and 10" x 6" units. A novel 10" full-range and new 8" and 12" "Triaxials" have also been added to the line.

PORTABLE MEGAPHONE

35 **University Loudspeakers, Inc.** has just introduced a transistorized, high-power portable megaphone with self-contained power supply. Its transistorized 25-watt amplifier is powered from lantern-type batteries.

The amplifier is specially designed for low distortion and high stability over a wide range of temperature variation. A ruggedly constructed, hand-held dynamic mike is designed to provide the type of service required of such portable equipment. Frequency response is 400-5000 cps at the 25 watt level. Acoustic gain is 40 db minimum while the sound pressure output is 97 db above .0002 microbar at 100 ft. Dispersion is 120 degrees. Input impedance at the phone jack is 20,000 ohms.

The circuit incorporates a "talk-back" feature which permits the megaphone to be used as a sensitive listening device. There is also an input jack for a standard phone plug, permitting the unit to be used in conjunction with a record player, tuner, or tape recorder.

CB-HAM-COMMUNICATIONS

CALL-LETTER SIGNS

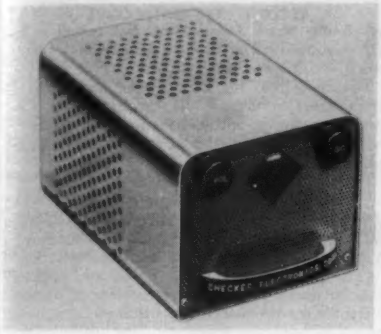
36 **Redicraft Products Company** has introduced a new accessory for ham and CB operators—a call-letter sign that is glass-bead reflectorized for day and night visibility. The call letters are per-

manently embossed in sheet aluminum and then given a slick, black, baked enamel finish.

FM MONITOR-RECEIVER

37 **Checker Electronics Corp.** has added a new FM monitor-receiver to its line of communications equipment.

Called the "Defender," the unit features a 12-



volt hybrid circuit for increased range and lower maintenance cost. The unit can be used on either 12-volt battery or with an a.c. power supply as a base station. The unit is designed for monitoring or receiving police calls, fire reports, CD instructions, etc. It is being offered in low-band (RA-52) and high-band (RA-150) models.

The monitor includes a self-contained speaker with a standard jack for external speaker if desired. The unit is housed in a polished chrome case that measures 4⅝" high x 5½" wide x 8⅝" long and weighs 5 pounds.

DUAL-RECEIVER

38 **Hammarlund Manufacturing Company** has announced production of a combination receiver that permits continuous monitoring of audio frequencies from 10 kc. to v.h.f. frequencies up to 54 mc.

The new dual-unit employs two matched SP-600 receivers which feature exceptionally low frequency drift and uniform sensitivity over the entire frequency range—measured to a 10:1 signal-plus-noise to noise-power ratio. The matched units provide reception of AM radiotelephone c.w. telegraph, AM-m.c.w. telegraph, carrier-shift teletypewriter, and many military communications.

The receivers are especially suited as professional or laboratory instruments for seeking, measuring, or receiving information.

20-WATT MOBILE UNIT

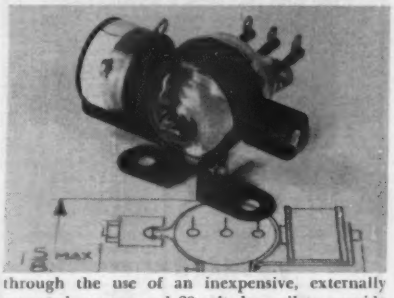
39 **Aeronautical Electronics, Inc.** has added a 20-watt low-band mobile radio set to its line of two-way radio equipment. The Model 7N20/TVR utilizes single-unit construction with all operating controls conveniently located on the front panel. All units have provision for a local and remote control as well as provision for the plug-in installation of "Unicall."

Housed in a deep-drawn aluminum cabinet, the unit can also be used as a base station operating

on 117-volts a.c. A transistorized power supply is incorporated into the design of the set and operates on either negative- or positive-ground battery systems.

VACUUM ANTENNA RELAY

40 **Jennings Radio Manufacturing Corp.** is marketing its new RPI vacuum antenna relay which has been designed specifically for amateur kilowatt service. Economy has been achieved



through the use of an inexpensive, externally mounted magnet and 28-volt d.c. coil to provide the actuating force necessary for movement of the enclosed contacts.

The conservative r.f. ratings are 1 kv. 4 amps r.m.s.

CB ANTENNA SYSTEM

41 **Hudson Sales Company** is offering a prewound coil extension which, when combined with the average automobile antenna, forms an antenna system for class D 27-mc. CB service.

This new mobile system eliminates installation of mounts and the typical 80-inch whip. The high-gain "Tronics" will also tune the 15- and 10-meter amateur frequencies by extending the center section of the car antenna. The body portion of the device is formed of non-conductive material and good electrical contact with the auto antenna is provided by a compression spring.

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0Z4	3BZ6	5V6GT	6AU8	6BR8	6D6	6SG7	7B5	12AQ5	12D4	24A
1A7GT	3CB6	5X8	6AV5GT	6BS8	6DE6	6SH7	7B6	12AQ8	12F5	25Z6GT
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1L4	3V4	6AB4	6AX4GT	6C4	6F6	6SQ7	7C5	12AU7	12L6	35B5
1L6	4BQ7A	6AF4	6AX5GT	6CA8	6F5	6SR7	7C6	12AV6	12Q7	35C5
1N5GT	5BS8	6AG5	6BA	6CB6	6F8	6T4	7C7	12AV7	12R5	35W4
1R5	4BZ7	6AH4GT	6BA6	6CD6G	6J4	6T8	7E5	12AX4GT	12SA7	35Z5
1S5	4CB6	6AH6	6BC5	6CF6	6J5	6U5	7E6	12AX7	12SJ7	36
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2BN4	5CG8	6AQ7	6BJ6	6CN7	6S4	6Y6G	7Q7	12BF6	14A7/12B5	50A5
2CY5	5J6	6AR5	6BK5	6CQ8	6S7	7A4/XXL	7S7	12BH7	14B6	50C5
3A5	5R4	6AS5	6BK7	6CR6	6S8GT	7A8	7X6	12BQ6	14Q7	50L6
3AL5	5T8	6AT6	6BL7GT	6CS6	6SA7	7A8	7X7	12BR7	19AU4GT	56
3AU6	5U4	6AU6	6BN6	6CS7	6SD7GT	7A7	7Y4	12BY7	19BG6G	84/6Z4
3BC5	5U8	6AU4GT	6BQ6GT	6CU5	6SF5	7A8	7Z4	12CA5	19J6	117Z3

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Just a minor repair or some tube replacement will make these sets work like new! Fix up like sets of your own for new or second set or for re-sale! 16", 17", 19" as is $17.49
Sets shipped FOB. Harrison, N.J.

SPECIAL SALE ON THESE TYPE TUBES: NOW 35¢ each
($29.95 per 100 in any assortment)
6AC7 5W4GT 6SN7GT

BRAND NEW PORTABLE TUBE TESTERS
Tests all radio and TV tubes in use PLUS 6 and 12 volt vibrators. Charts and 12 volt new tube types are available as for large and small tubes. Highly accurate solder, etc. Highly accurate tube checker, built right into the caddy, is easiest to use. $53.95
F.O.B. Harrison, N.J.

TUBE CADDY WITH BUILT-IN TUBE CHECKER
Here is the serviceman's dream companion. Holds up to 150 tubes. Contains huge specially designed compartment for large and small tools, solder, etc. Highly accurate tube checker, built right into the caddy, is easiest to use. $53.95
F.O.B. Harrison, N.J.

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Customers can check own tubes. Complete with attractive back panel and safety key for bottom tube compartment. F.O.B. Harrison, N.J. $38.95
Weight Approx. 45 Lbs.

Prepaid $38.95
In handsome leatherette carrying case.
Shipped

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5719-R Santa Monica Blvd., Hollywood 38, Calif.

The upper whip portion extends only 36 inches above the coil. Over-all length of the unit is just 45 inches.

LOW-COST 2-WAY RADIO

42 **Outercom Electronics Corporation** has announced the availability of a high-power, low-cost 2-way business radio, the FM-50A. The

new unit provides up to 35 watts output and comes complete with microphone and built-in power supply for use on 6- or 12-volts d.c. or 117 volts a.c.

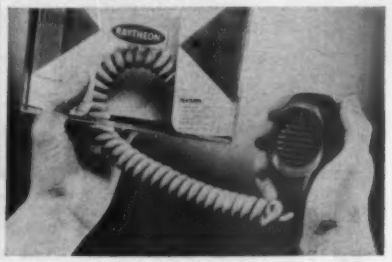
Since the unit is entirely self-contained, it may be switched from vehicle to vehicle or from base station to vehicle, thus reducing the initial investment by the small operator.

MOBILE MIKE

43 **Raytheon Company's** Distributor Products Division has introduced a new press-to-talk microphone which has been designed for trouble-free operation even under severe conditions encountered with mobile and marine radio-telephone equipment.

The "Elucidator" is molded of practically indestructible high-impact plastic in banker's gray. It has a 11" to 60" retractable coiled cord in light gray for a two-tone effect.

Employing a standard F1-type carbon button,



bypassed for r.f., the microphone provides good intelligibility within the voice range. Frequencies below 200 and above 4000 cycles are attenuated to taper the spectrum and accommodate the restricted bandwidth requirements of most modern communications equipment.

MANUFACTURERS' LITERATURE

MINIATURE WIREWOUNDS

44 **Ortho Precision Resistors Inc.** has just published a new 6-page, 2-color catalogue covering its entire line of miniaturized wirewound resistors.

It features a comprehensive manual of terms and definitions necessary to the understanding and ordering of wirewound resistors, diagrams and specifications on 20 standard axial-lead and printed-circuit type resistors, a table describing the characteristics of resistance wire, and a table describing the relation between maximum possible resistance and wire types.

ZENER DIODE BULLETIN

45 **CBS Electronics** is offering copies of a four page bulletin covering zener diode theory, characteristics, and applications. Typical circuits using zener diodes are shown for shunt regulation of both a.c. and d.c. voltage, the voltage reference element in a transistor-controlled regulated power supply, the cathode resistor in vacuum-tube amplifiers, the regulation of vacuum-tube heaters, and the suppressed-zero voltmeter with expanded scale.

Written by Bud Tomer, this is one of the firm's "Tech Tips" series of booklets.

RECORD/TAPE CATALOGUE

46 **Radio Shack Corporation** has issued a 24-page record and tape catalogue which is currently available without charge.

Catalogue No. 105 lists a wide variety of famous label recordings of classics, pops, jazz, Broadway shows, novelties, and other types as well as a catalogue of books available at discount prices.

RESISTORS AND RHEOSTATS

47 **Tru-Ohm Products** is currently distributing copies of its new D-61 catalogue which covers a complete line of resistors and rheostats.

The publication not only covers the complete line in detail but suggests a variety of applications for the products. Included are fixed vitreous enameled resistors from 10 to 200 watts, a complete line of axial-lead vitreous enamel resistors, type VAL units ranging from 3 to 20 watts, and rheostats, with knobs, rated from 25 to 300 watts.

TUNNEL DIODE DATA

48 **Transitron Electronic Corporation** has issued a 16-page handbook on circuit design of the tunnel diode.

The "Tunnel Diode Circuit Design Handbook" (Booklet No. AN-1359A) contains sections on the theory of tunneling action; various general circuit considerations; simple switching circuit ("or" gate, "and" gate, "majority" gate, and "fan-out" considerations); and four common digital circuits including shift register, ring counter, binary counter, and memory circuit.

CHASSIS PUNCHES

49 **Greenlee Tool Co.** is offering copies of its Folder E236 which describes and illustrates the firm's line of chassis punches for cutting clean openings for sockets, electronic controls, meters, and other components.

The brochure gives complete details on all size chassis punches for making round, square, key, "D" and double "D" openings in metal, hard rubber, and plastics. It also contains information on knockout punch drivers and punches for making holes up to 5⅛" diameter in metal.

INDUSTRIAL PRODUCT CATALOGUE

50 **Radio Parts Company, Inc.** has issued a 224-page guide to the newest industrial electronic products, listing latest prices and complete specifications on a wide range of electronic parts, equipment, and accessories. Some 115 manufacturers are included in this listing.

The catalogue also includes a listing of products available through the distributor at O.E.M. prices.

PULSE-TRANSFORMER DATA

51 **Hamilton Watch Company's** Electronics Division has issued two new technical bulletins covering design and test specifications on its line of pulse transformers.

Technical Data Sheet 901 details test procedures used for the evaluation of pulse transformers along with a schematic diagram of the company's standard test HST-1.

Technical Data Sheet 902 describes pulse transformer kit PTK-1 used to assist in the design of new circuits where the exact transformer need is unknown. The sheet provides schematics of the PTK-1 and test circuit.

PICTURE TUBE BRIGHTENERS

52 **Perma-Power Company** has announced the availability of a new "Britener Selector Guide and Supplement" which lists every TV picture tube in general use, along with recommendations for Briteners that are compatible with individual tubes.

Copies of this 12-page publication, prepared especially for service technicians, are available without charge.

INSTRUMENT SPECS

53 **Ballantine Laboratories** has announced the availability of an 8-page "short-form" catalogue which contains illustrations and technical data on precision, laboratory-type voltmeters, decade amplifiers, calibrators, capacitance meters, a.c.-d.c. converters, and d.c.-a.c. inverters.

TURNTABLES FOR STEREO

54 **Rek-O-Kut Company, Inc.** is now offering an illustrated, 8-page brochure which gives specifications and prices on its complete line of "Stereotables."

Seven models are included in the line, all of which feature hysteresis synchronous motors for locked-in accuracy of rotational speed at all times, irrespective of power-line fluctuation and load. The two-color brochure features side and front views of these instruments plus details on such accessories as bases and acoustical mounts, tonearms, etc.

AUDIO CABLE DATA

55 **Phalo Plastics Corp.** is now offering a 12-page bulletin which contains detailed product and technical data on cable constructions typically used in intercom, sound systems, public address, and related applications.

Information is grouped for easy application and covers cabled, shielded, jacketed 2-7 conductors; twisted pairs; cabled and jacketed 2-9 conductors; twisted pairs and triples; and miscellaneous constructions.

AUDIO REFERENCE GUIDE

56 **Switchcraft, Inc.** has issued a new "Reference Guide" to aid distributors, dealers, and customers in the proper selection of the firm's 2-input mike mixer, transistor mixer, and interconnecting cords for all types of tape recorders.

Available in standard reference page size and/or as a large wall chart, the new Guide lists all American-made tape recorders and the appropriate units to be used with that particular tape recorder. The publication features large product illustrations and easy-to-read columns.

TUBE HANDBOOKS

57 **Raytheon Company's** Industrial Components Division has issued three 12-page handbooks, published especially for equipment-design engineers and covering cathode subminiature, filamentary subminiature, and gas and vapor electron tubes.

Complete specifications are charted for some 340 industrial and military types in the handbooks which also diagram base and envelope connections and picture preferred tube types.

POWER TRANSISTORS/DIODES

58 **Silicon Transistor Corp.** has announced the availability of a new short-form catalogue covering its line of silicon power transistors and silicon glass diodes.

The new brochure lists the firm's line of intermediate and high-power transistors and a JEDEC and STC types cross-reference chart. The silicon glass diode listing includes military types, general-purpose types, fast switching, controlled forward, high-power types, and a high-current switching series.

HAND-TOOL "BUYER'S GUIDE"

59 **Vaco Products Company** is offering a comprehensive, 16-page illustrated buyer's guide covering a complete line of hand-tools for the electronics and electrical industry.

The new publication lists 216 individual numbers of screwdrivers and nut drivers plus over 250 other tool items and display units, including pliers, wrenches, specialty tools, Vari-Board shelves with stock, and Vari-Board tool selector displays. A complete alphabetical and numerical index is included. —30—

Answer to Puzzle Appearing on Page 93

		T	R	A	N	S	M	I	T	T	E	R		
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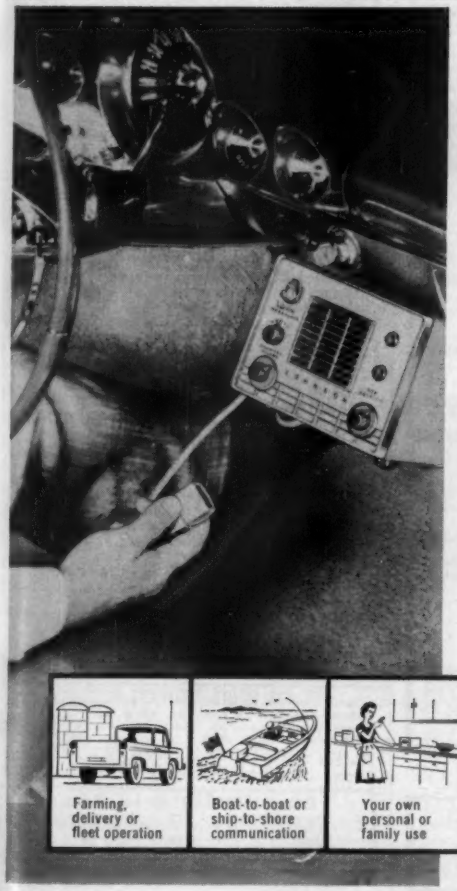
78	Acrosound
80	Sencore



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a complete, fully engineered "industrial-type" transceiver!

VIKING *Messenger*

Anyone can operate—license issued by the FCC on request

from $134.95

- Complete 23 channel Citizens' Band coverage—choose 1 of any 5 channels by the flip of a switch.
- Maximum legal power—excellent range—meets all FCC requirements.
- Excellent receiver sensitivity and selectivity—full fidelity voice reproduction.

"More than just 2-way Citizens' Radio equipment"—the Viking "Messenger" will deliver the finest performance of any equipment available in the field. Designed throughout for 10 watt power level—limited to 5 watts for Citizens' Radio. Easy to install anywhere in your home, business location, car, truck or boat . . . offers many unique features found only on more expensive communications systems. Built-in Squelch, Automatic Volume Control, and Automatic Noise Limiter. Compact, modern styling—only 5 5/8" high, 7" wide, and 11 3/8" deep. Complete with tubes, push-to-talk microphone, and crystals for one channel.

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Manufacturers of the world's most widely used personal communications transmitters

LORAN R-65/APN-9 RECEIVER & INDICATOR

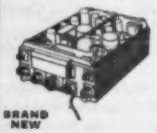
Used in ships and aircraft. Determines position by radio signals from known xmitters. Accurate to within 1% of distance. Complete with tubes and crystal. Exc. used. **Value $1200.00. Our Price** **$79.50**
Used, less tubes, crystal and visor, but with 3BP1 C.R. tube **$29.50**

INVERTER POWER SUPPLY for Loran. Made by Eclipse—Pioneer Div. INPUT: 24 V DC @ 75 A. OUTPUT: 115 V AC @ 10.5 Amps, 800 cycles. Complete with two connecting plugs BRAND NEW **$49.50**
12-Volt Inverter Power Supply, Like New .... P.U.R.
Shock Mount for above **$2.95**
Circuit diagram and connecting plugs available.
We carry a complete line of spare parts for above.

LORAN APN-4
FINE QUALITY NAVIGATIONAL EQUIPMENT

Determine exact geographic position of your boat or plane. Indicator and receiver complete with all tubes and crystal.
INDICATOR ID-68/APN-4, and RECEIVER R-98/APN-4, complete with tubes. Exc. used **$49.50**
Receiver-Indicator as above, BRAND NEW **$88.50**
INVERTER POWER SUPPLY for Loran. Made by Eclipse—Pioneer Div. INPUT: 24 V DC @ 75 A. OUTPUT: 115 V AC @ 10.5 Amps, 800 cycles. Complete with two connecting plugs BRAND NEW **$49.50**
12-Volt Inverter Power Supply, Like New. ... P.U.R.
Shock Mount for above **$2.95**
We carry a complete line of spare parts for above.

FAMOUS BC-645 TRANSCEIVER
15 Tubes 435 to 500 MC



BRAND NEW

Can be modified for 2-way communication, voice or code, on ham band 420-450 mc. citizens radio 460-470 mc, fixed and mobile 450-460 mc. television experimental 470-500 mc. 15 tubes (tubes alone worth more than sale price!); 4—7F7, 4—7H7, 2—7E6, 2—6F6, 2—955 and 1—WE-316A. Now covers 460 to 490 mc. Brand new BC-645 with tubes, less power supply in factory carton.
Shipping weight 25 lbs. **SPECIAL!** **$19.50**
PE-101E Dynamotor, 12/24V input **$7.95**
UHF Antenna Assembly **2.45**
Complete Set of 10 Plugs **1.50**
Control Box **3.25**

SPECIAL "PACKAGE" OFFER:
BC-645 Transceiver, Dynamotor and all accessories above. COMPLETE, BRAND NEW, **$29.50**
While Stocks Last.....

LORAN APN/4 OSCILLOSCOPE

Easily converted for use on radio-TV service bench.

Completely Assembled
LIKE NEW! Supplied with 5" Scope, type 5CP1 only **$14.50**

ARN-5-C AIRBORNE Equipment, to give vertical guidance during landings. 11 tube superhet circuit. Tubes: 28D7, 12SH7, 2-12SN7, 7-6AJ5. 6 Crystals. Exc. Used **$12.95**

BC-733 VHF 10-Tube Aircraft Receiver. 6-channel crystal control. Freq. 108.3 to 110.3 Mc. Dual filter range. Easily converted for tracking Sputnik! Exc. Used **$9.95**

SCR-274 COMMAND EQUIPMENT

ALL COMPLETE WITH TUBES Type	Description	Used	Like NEW
BC-453	Receiver 190-550 KC	$12.95	$14.95
1.5-3 Mc Receiver, Brand New $16.95			
BC-454	Receiver 3-6 Mc	10.45	12.45
BC-455	Receiver 6-9 Mc	11.50	13.95

110 Volt AC Power Supply Kit, for all 274-N and ARC-5 Receivers. Complete with metal case. Instructions **$7.95**
Factory wired, tested, ready to operate... **$11.50**
SPLINED TUNING KNOB for 274-N and ARC-5 RECEIVERS. Fits BC-453, BC-454 and others. Only **49c**

BC-457 TRANSMITTER—4-5.3 Mc. complete with all tubes and crystal, BRAND NEW.. **$9.75**
BC-458 TRANSMITTER—5.3 to 7 Mc. Complete with all tubes and crystal. BRAND NEW **$9.75**
BC-459 TRANSMITTER—7-9.1 Mc. com... complete with all tubes and crystal. Exc. Used **$13.95**
BC 696 TRANSMITTER 3-4 mc complete with all tubes and crystal. Exc. used **$9.95**
BC-456 Modulator ..... **USED 3.45 NEW 5.95**
MD7 Modulator, Like New **$9.95**
ALL ACCESSORIES AVAILABLE FOR ABOVE

SMALL DC MOTORS
All 27.5 DC Input

Overall 3¾"x1¼" Dia.

5069790	100 RPM Delco	$3.95
5BA10AJS2	145 RPM GE	4.25
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5072738	200 RPM Delco	3.95
5067127	250 RPM GE	4.25
5069800	575 RPM Delco	3.75
5BA10FS226A	575 RPM GE	3.75

2 VOLT BATTERY "PACKAGE"

1—2V, 20 Amp. Hr. Willard Storage Battery. Model ±20-3. 3" x 4" x 5¼" high $2.79
1—2V, 7 prong Synchronous Plug-in Vibrator 1.49
1—Quart Bottle Electrolyte (for 2 cells) 1.45
ALL BRAND NEW!
Combination Price **$5.45**

SCHEMATIC DIAGRAMS For most equipment on this page, each.. **65c**

BC-603 FM RECEIVER
20 TO 27.9 MC.

Excellent Used **$14.95**
BRAND NEW **$18.95**
10-channel, pushbutton or continuous tuning. Complete with speaker, squelch, and ten tubes: 3-6AC7, 1-6J5, 2-12SG7, 1-6H6, 1-6V6, 2-6SL7.
EXTRA SET OF 10 TUBES FOR ABOVE brand new in original boxes $3.95

FT-237 MOUNTING BASE for BC-603 Rcvr and BC-604 Xmitter. Brand New **$5.95**
12 or 24V Dynamotor for Above. Exc. Used $4.25 ..... Brand New **$5.50**
BC-683 FM Receiver, 27 to 38.9 Mc. Complete with all tubes. Like New **$33.33**
4-Section Antenna for BC-603, 683 Receivers. Complete with mounting base. BRAND NEW **$4.95**
BC-604 TRANSMITTER—Companion unit for BC-603 Rcvr above. With all tubes. BRAND NEW **$6.95**
4-Section Antenna for BC-604, 684 Transmitters. Complete with mounting base. BRAND NEW .. **$4.95**
We carry a complete line of spare parts for above.

SPECIAL! BC-603 FM RCVR CONVERTED FOR ANY FREQ.—30 TO 50 MC.
BRAND NEW! Checked out, perfect working condition, ready for operation. Specify Frequency desired (between 30-50 Mc) when ordering. **$27.50**

AC POWER SUPPLY FOR BC603, 683
Interchangeable, replaces dynamotor. Has On-Off Switch. NO RECVR. CHANGE NEEDED. Provides 230 VDC @ 80 Ma, 24VAC @ 2 Amps. $9.25
Complete 240-page Technical Manual for BC-603, 604 ..... $3.15

BC-605 INTERPHONE AMPLIFIER for above. **BRAND NEW** ..... **Each $4.95**

BC-638A FREQUENCY METER 100-156 Mc. Xtal controlled. Rack mounting. For 110V AC operation. Less crystals. BRAND NEW **$29.50**

BENDIX DIRECTION FINDERS
For commercial navigation on boats.

MN26Y 150-325 Kc; 325-695 Kc; 3-4.7 Mc. Complete with tubes, dynamotor, BRAND NEW	$19.50
MN28Y Receiver Control Box	$ 4.95
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MN26C Receiver as above, BRAND NEW	27.50
MN20E Rotatable Loop for above	4.25
MN32 Azimuth Control Box	2.95
Flexible Mechanical Cable for Above	3.95
MN28C Receiver Control Box	4.95

Other Accessories available from stock.

TS-16/APN TEST SET

For aligning and calibration of radio altimeters. May be used to check calibration of count or circuits and modulator sweep freq. and bandwidth of transmitter. Audio-oscillator ranges 340 to 7350 cycles. 19/14 V.DC input. Complete with tubes, connecting cables, instruction summary, BRAND NEW ... **$9.95**

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195 to 420 Kc. made by Setchel - Carlson. Works on 24-28 volts DC. 135 Kc. IF. Complete with 5 tubes. Size 4" x 4" x 6". Wt. 4 lbs. BRAND NEW ... **$9.99**
Brand New, less tubes... $5.95
USED, with tubes..... 5.95
USED, less tubes..... 2.95

SCR-522 2-METER RIG!
Terrific buy! VHF Transmitter-receiver. 100-156 Mc. 4 channels. Xtal-controlled. Amplitude modulated voice. They're going fast! Excellent condition.
SCR-522 Transmitter-Receiver, complete with all 18 tubes, top rack and metal case.
COMBINATION. Exc. Used **$29.50**

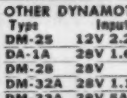
DYNAMOTOR ASSEMBLY

Very fine unit, made by Collins Radio. Consists of TWO Dynamotors mounted on filter base.

	INPUT	OUTPUT
Dynamotor #1	12VDC @ 3.8A	220VDC @ 100 Ma,
Dynamotor #2	12VDC @ 9.9A	400VDC @ 180 Ma.

BRAND NEW, in original packing, shpg wt 29 lbs. **OUR LOW PRICE** **$9.95**

MOBILE-MARINE DYNAMOTOR
Model DM35



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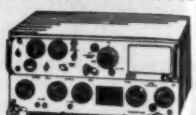

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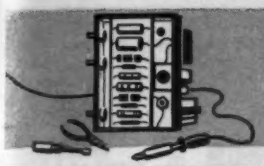

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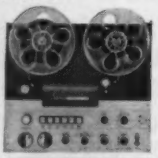

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Sun	Mon	Tue	Wed	Thu	Fri	Sat
						5
						12
						19
						26

JUNE 19-20

Second National Conference on Broadcast & Television Receivers. PGBTR and Chicago Section of IRE. O'Hare Inn, Des Plaines, Illinois. Contact Neil Frihardt, Motorola Inc., 4545 W. Augusta Blvd., Chicago, Ill. for program details.

JUNE 26-28

Fifth National Convention on Military Electronics. Sponsored by PGME of IRE. Shoreham Hotel, Washington, D.C. Harry Davis, SAFRD, Pentagon, Washington 25, D.C. for program details.

JUNE 28-30

Joint Automatic Control Conference. Sponsored by PGAC, ISA, AIEE, AICHE, and ASME. University of Colorado, Boulder, Colo. Dr. Robert Kramer, Electrical Systems Lab., MIT, Cambridge 39, Mass. for program details.

JULY 10-14

Fourth Annual Institute in Technical and Industrial Communications. Sponsored by and held at Colorado State University, Fort Collins, Colo. Information available from Dr. Herman M. Weisman of the University.

JULY 16-20

1961 Music Industry Trade Show. Sponsored by National Association of Music Merchants. Palmer House, Chicago. Details from NAMM, c/o Cooper, Burns & Golin, 203 N. Wabash Ave., Chicago 1, Illinois.

JULY 16-21

Fourth International Conference on Medical Electronics & 14th Conference on Electronic Techniques in Medicine & Biology. Sponsored by IFME, JECMB, IRE-PGBME. Waldorf-Astoria Hotel, New York, N.Y. Program information from Dr. Herman P. Schwan, University of Pennsylvania, School of Electrical Engineering, Philadelphia, Pa.

AUGUST 1-3

Fourth Western Regional Meeting of the American Astronautical Society. Sponsored by AAS. Sheraton-Palace Hotel, San Francisco. Saunders B. Kramer, Lockheed Missiles and Space Div., Sunnyvale, Calif. is general chairman.

AUGUST 16-18

Second International Electronic Circuit Packaging Symposium. Sponsored by the Department of Electrical Engineering and Bureau of Continuation Education, University of Colorado, Boulder, Colo. Information on program available from the Bureau.

AUGUST 18-20

NATESA Annual Convention. Sponsored by National Alliance of Television & Electronic Service Associations. Pick-Congress Hotel, Chicago. Frank J. Moch, Executive Director, 5906 S. Troy St., Chicago 29, Illinois for details.

AUGUST 22-25

1961 Western Electronic Show and Convention. Sponsored by 7th Region of IRE and WEMA. Cow Palace, San Francisco, Calif. Information available from WESCON, 1435 S. La Cienega Blvd., Los Angeles 35, Calif.

AUGUST 30-SEPTEMBER 1

Third Annual AIME Semiconductor Conference. Sponsored by the Metallurgical Society of AIME and the Southern California Section of AIME. Ambassador Hotel, Los Angeles. Pre-registration with J. O. McCaldin, 11601 Montana Ave., Los Angeles 49, Calif.

SEPTEMBER 5-8

16th National Conference of the Association for Computing Machinery & First International Data Processing Exhibit. Statler Hilton, Los Angeles, Calif. B. J. Handy, Jr., Litton Systems, 5500 Canoga Ave., Woodland Hills, Calif., chairman.

SEPTEMBER 6-8

1961 Joint Nuclear Instrumentation Symposium. N.C. State College, Raleigh, N.C. Contact H. S. McCreary, Westinghouse Special Atomic Project, 107 Terrace Court, Pittsburgh 27, on program.

National Symposium on Space Electronics & Telemetry. Sponsored by PGSET of IRE. Albuquerque, N.M. Program details from Dr. B. L. Basore, 2405 Parsifal, N.E., Albuquerque, N.M.

SEPTEMBER 6-13

International Conference on Electrical Engineering Education. Sponsored by ASEE, IRE, AIEE, and Syracuse University. Sagamore Conference Center, Syracuse University, Adirondacks, N.Y. Information from W. R. LePage, Syracuse University, Syracuse, N.Y.

SEPTEMBER 13-17

1961 New York High-Fidelity Music Show. Sponsored by Institute of High Fidelity Manufacturers, Inc. New York Trade Show Building, 500 Eighth Ave., New York City. Show hours to be announced later.

SEPTEMBER 14-15

Ninth Annual Engineering Management Conference. Sponsored by PGEM, AIEE, et al. Roosevelt Hotel, New York, N.Y. Details from H. M. O'Bryan, General Telephone & Electronics Labs., 730 Third Ave., New York City, N.Y.

Symposium on Engineering Writing & Speech. Sponsored by Philadelphia Section of PGEWS. Bellevue-Stratford Hotel, Philadelphia. George Boros, 2035 Pine St., Philadelphia 3, for program details.

SEPTEMBER 20-21

Joint Industrial Electronics Symposium. Sponsored by AIEE, IRE, and Instrument Society of America. Bradford Hotel, Boston. For information on reservations, contact D. J. LaCerda, Badger Mfg. Co., 363 Third St., Cambridge, Mass.

OCTOBER 2-4

Seventh National Communications Symposium. Sponsored by PGCS of IRE, Rome-Utica Section. Utica, N.Y. Program information from R. K. Walker, 34 Balton Rd., New Hartford, New York.

IRE Canadian Electronics Conference. Sponsored by Region 8 of the IRE. Automotive Bldg., Exhibition Park, Toronto, Ont. Details from A. R. Law, c/o IRE Canadian Electronics Conference, 1819 Yonge St., Toronto, Ontario, Canada.

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	1AX2	.62		6BA6	.50		12AJ6	.46
	1B3GT	.79		6BC5	.61		12AL5	.45
	1DN5	.55		6BC7	.94		12AL8	.95
	1G3	.79		6BC8	.97		12AQ5	.52
	1J3	.79		6BD6	.51		12AT6	.43
	1K3	.79		6BE6	.55		12AT7	.76
	1LN5	.59		6BF6	.44		12AU6	.50
	1R5	.62		6BG6	1.66		12AU7	.61
	1S5	.51		6BH6	.65		12AV5	.97
	1T4	.58		6BH8	.87		12AV6	.41
	1U4	.57		6BJ6	.62		12AV7	.75
	1U5	.50		6BK7	.85		12AX4	.67
	1X2B	.82		6BL7	1.00		12AX7	.63
	2AF4	.96		6BN4	.57		12AZ7	.86
	3AL5	.42		6BN6	.74		12B4	.63
	3AU6	.51		6BQ5	.65		12BA6	.50
	3AV6	.41		6BQ6GT	1.05		12BD6	.50
	3BA6	.51		6BQ7	1.00		12BE6	.53
	3BC5	.54		6BR8	.78		12BF6	.44
	3BE6	.52		6BU8	.70		12BH7	.77
	3BN6	.76		6BY6	.54		12BL6	.56
	3BU8	.78		6BZ6	.55		12BQ6	1.06
	3BY6	.55		6BZ7	1.01		12BY7	.77
	3BZ6	.55		6C4	.43		12BZ7	.75
	3CB6	.54		6CB6	.55		12C5	.56
	3CF6	.60		6CD6	1.42		12CN5	.56
	3CS6	.52		6CF6	.64		12CR6	.54
	3DK6	.60		6CG7	.61		12CU5	.58
	3DT6	.50		6CG8	.77		12CU6	1.06
	3Q5	.80		6CM7	.66		12CX6	.54
	3S4	.61		6CN7	.65		12DB5	.69
	3V4	.58		6CR6	.51		12DE8	.75
	4BC8	.96		6CS6	.57		12DL8	.85
	4BN6	.75		6CU5	.58		12DM7	.67
	4BQ7	1.01		6CU6	1.08		12DQ6	1.04
	4BS8	.98		6CY7	.71		12DS7	.79
	4BU8	.71		6DA4	.68		12DZ6	.56
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	4CS6	.61		6DG6	.59		12EZ6	.53
	4DE6	.62		6DQ6	1.10		12F8	.66
	4DK6	.60		6DT5	.76		12FM6	.45
	4DT6	.55		6DT6	.53		12K5	.65
	5AM8	.79		6EU8	.79		12SA7M	.92
	5AN8	.86		6EA8	.79		12SK7GT	.74
	5AQ5	.52		6H6GT	.58		12SN7	.67
	5AT8	.80		6J5GT	.51		12SQ7M	.78
	5BK7A	.82		6J6	.67		12U7	.62
	5BQ7	.97		6K6	.63		12V6GT	.53
	5BR8	.79		6S4	.51		12W6	.69
	5CG8	.76		6SA7GT	.76		12X4	.38
	5CL8	.76		6SK7	.74		17AX4	.67
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	5EU8	.80		6SN7	.65		17C5	.58
	5J6	.68		6SQ7	.73		17CA5	.62
	5T8	.81		6T4	.99		17D4	.69
	5U4	.60		6U8	.83		17DQ6	1.06
	5U8	.81		6V6GT	.54		17L6	.58
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	6AB4	.46		6X5GT	.53		19T8	.80
	6AC7	.96		6X8	.80		21EX6	1.49
	6AF3	.73		7AU7	.61		25BQ6	1.11
	6AF4	.97		7A8	.68		25C5	.53
	6AG5	.68		7B6	.69		25CA5	.59
	6AH6	.99		7Y4	.69		25CD6	1.44
	6AK5	.95		8AU8	.83		25CU6	1.11
	6AL5	.47		8AW8	.93		25DN6	1.42
	6AM8	.78		8BQ5	.60		25EH5	.55
	6AQ5	.53		8CG7	.62		25L6	.57
	6AR5	.55		8CM7	.68		25W4	.68
	6AS5	.60		8CN7	.97		25Z6	.66
	6AT6	.43		8CX8	.93		35C5	.51
	6AT8	.79		8EB8	.94		35L6	.57
	6AU4	.82		11CY7	.75		35W4	.42
	6AU6	.52		12A4	.60		35Z5GT	.60
	6AU7	.61		12AB5	.55		50B5	.60
	6AU8	.87		12AC6	.49		50C5	.53
	6AV6	.41		12AD6	.57		50DC4	.37
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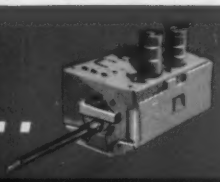

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In this and every respect, RCA Silverama Picture Tubes are built to the highest standards of the picture tube industry. They contain an all-new electron gun, all-new parts and materials except for the envelope which is used.

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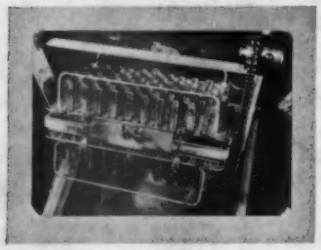

Guns emerging from ultrasonic cleaning tank. Still in the same tray, they are placed immediately in the radiant drying oven shown in the photograph at right.

Gun mounts are dried for one hour at 150°C (302°F.). Then, super-dry and super-clean, they are taken out for final processing in our dust-free "White Room".

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